OPERATING AND SERVICE MANUAL

MODEL 211B

SQUARE WAVE GENERATOR

SERIALS PREFIXED: G 621

00211 - 90000

PRINTED: JUNE, 1966

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Specifications

50 and 600 ohm Outputs

SYMMETRY CONTROL: Continuously variable from 25% - 75% duty cycle.
POLARITY: Negative
PHASE DIFFERENCE: 180^{o} between 50Ω and 600Ω outputs at 50% duty cycle.

50 ohm Output

SOURCE IMPEDANCE: 50Ω ±3% shunted by approximately 15pF.
PULSE SHAPE: (Measured at 5 V across 50Ω)
RISE AND FALL TIMES: < 5ns
OVERSHOOT AND RINGING: < 5% peak of pulse amplitude.
PRESHOOT: < 5%

AMPLITUDE

MAXIMUM OUTPUT: 5 V across 50Ω, 10 V across an open circuit. Output circuit protected, cannot be damaged by shorting.
ATTENUATOR: Provides 7 steps from 0.05 to 5 V in a 1, 2.5, 5 sequence.
VERNIER: Provides continuous adjustment between ranges, minimum output less than 0.02V across 50Ω. Rotating vernier to minimum (ccw) may increase preshoot to 10%.

600 ohm Output

SOURCE IMPEDANCE: 600Ω ±10%

PULSE SHAPE

RISE AND FALL TIMES: < 70ns across 600Ω, less than 140ns across an open circuit. Decreased amplitude setting will improve rise time.

OVERSHOOT AND RINGING: < 5%

AMPLITUDE

MAXIMUM OUTPUT: 30 V across 600Ω, 60 V across an open circuit.
ATTENUATOR: Provides continuous adjustment from full output to less than 0.3 V across 600Ω.

Repetition Rate and Trigger Output

FREE RUN

REPETITION RATE
50Ω output: 1 Hz to 10 MHz, 7 ranges
600Ω output: 1 Hz to 1 MHz, 6 ranges
DIAL CALIBRATION: 1 - 10 (linear)
DIAL ACCURYCY: ±5% to 10 MHz at 50% duty cycle. Variation of symmetry control may change frequency and additional ±5% (10% on 10 MHz range).
PERIOD JITTER: < 0.2% at any duty cycle and repetition rate setting.

SYNCHRONIZATION

SYNC INPUT: DC coupled, sine waves or positive pulses from 1 Hz to 10 MHz. Frequency of synchronizing signal must be 105% - 140% of dial setting.
SENSITIVITY: Will synchronize on positive pulses of at least 1 V, sine waves of at least 2 V peak to peak.
INPUT IMPEDANCE: Approximately 500Ω

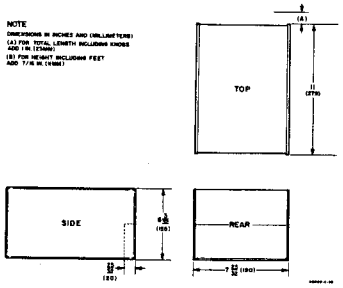
TRIGGER OUTPUT PULSE: (suitable for synchronization with another 211B).

WIDTH: 10 (±5) ns at 50% points.
AMPLITUDE: At least 2 V across 50Ω
TIMING: Coincident with leading edge of 50Ω pulse
POLARITY: Positive or Negative

General

POWER: 115 or 230 V ±10% - 15%, 50 Hz to 400 Hz, 23 W.

DIMENSIONS:



WEIGHT: Net, 9lbs (4kg). Shipping 11 lbs (5kg)

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The -hp- Model 211B Square Wave Generator (shown in Figure 1-1) is a compact, general purpose instrument providing negative pulses of variable frequency, symmetry and amplitude. Complete specifications of performance are given in Table 1-1. Two independent outputs are available. The 50Ω source supplies pulses with 5ns rise and fall times and a peak output of 5 volts across 50Ω. Simultaneously, a 600Ω source provides pulses of 30 volts across 600Ω having a rise and fall time of 70ns. Matched output impedance provide twice the voltage across an open circuit. Amplitude for both pulses is seperately controllable. The frequency range of the instrument, 1 Hz to 10 MHz, is covered in 7 decade ranges with a linearly calibrated dial for continuous adjustment on all positions. The 50Ω output operates to 10 MHz, the 600Ω output to 1 MHz. The duty cycle can be varied from 25% to 75%.

1-3. Trigger output pulses, for synchronizing external circuits or instruments, have a pulse width of less than 20ns, reversible polarity and an amplitude of at least 2 volt across 50Ω. The trigger output is coincident with the leading edge of the 50Ω output. The 211B operates free running or may be synchronized with external signals of either sinewaves or positive pulses.

1-4. MANUAL IDENTIFICATION.

1-5. Information in this manual applies directly to Modell 211B instruments with serial prefix of G-621 The serial prefix is the first three digits of the eight-digit serial number (e. g. 000-00000) used to indentify each -hp- instrument. If the serial prefix of a Model 211B is not G-621, a manual change sheet supplied with the manual will define the differences between that Model 211B and the one described in this manual, or a different manual will provide correct information. Corrections to this manual, due to errors that existed when it was printed, are called Errata and appear only on the change sheet supplied. To obtain correct manual information for any instrument, contact the nearest Hewlett-Packard Company Sales/Service Office and always specify the model number and serial number.

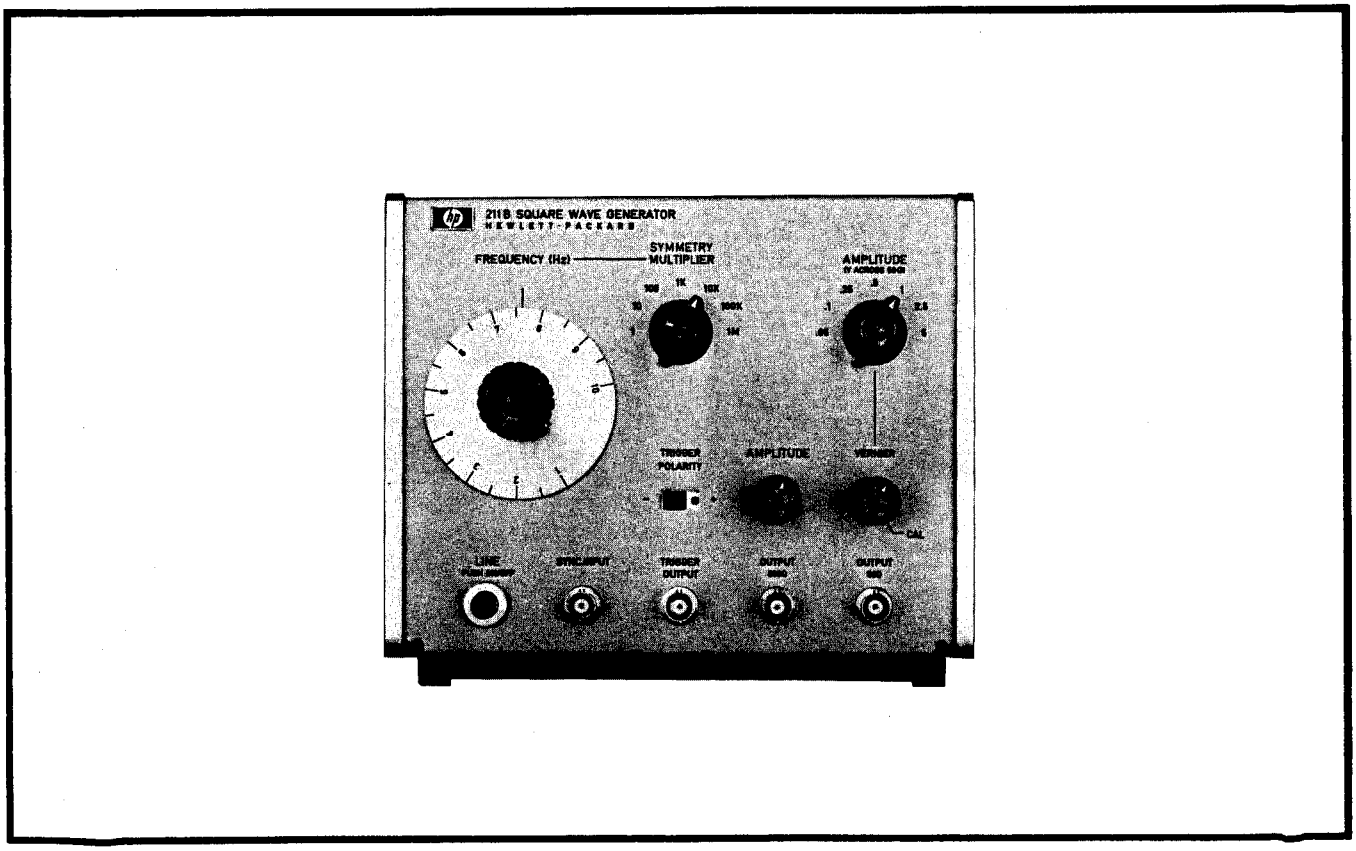


Figure 1-1 Model 211B Square Wave Generator

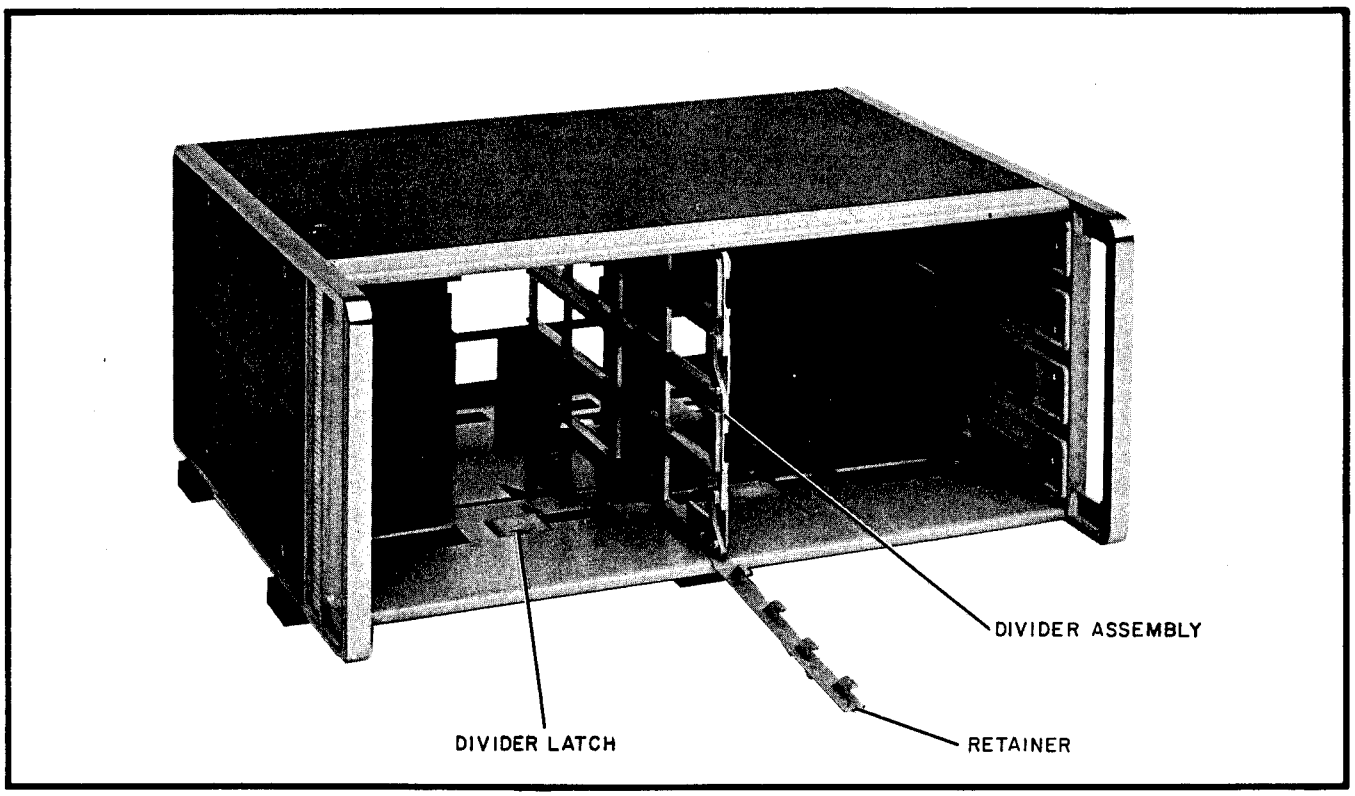


Figure 2-1 The Combining Case

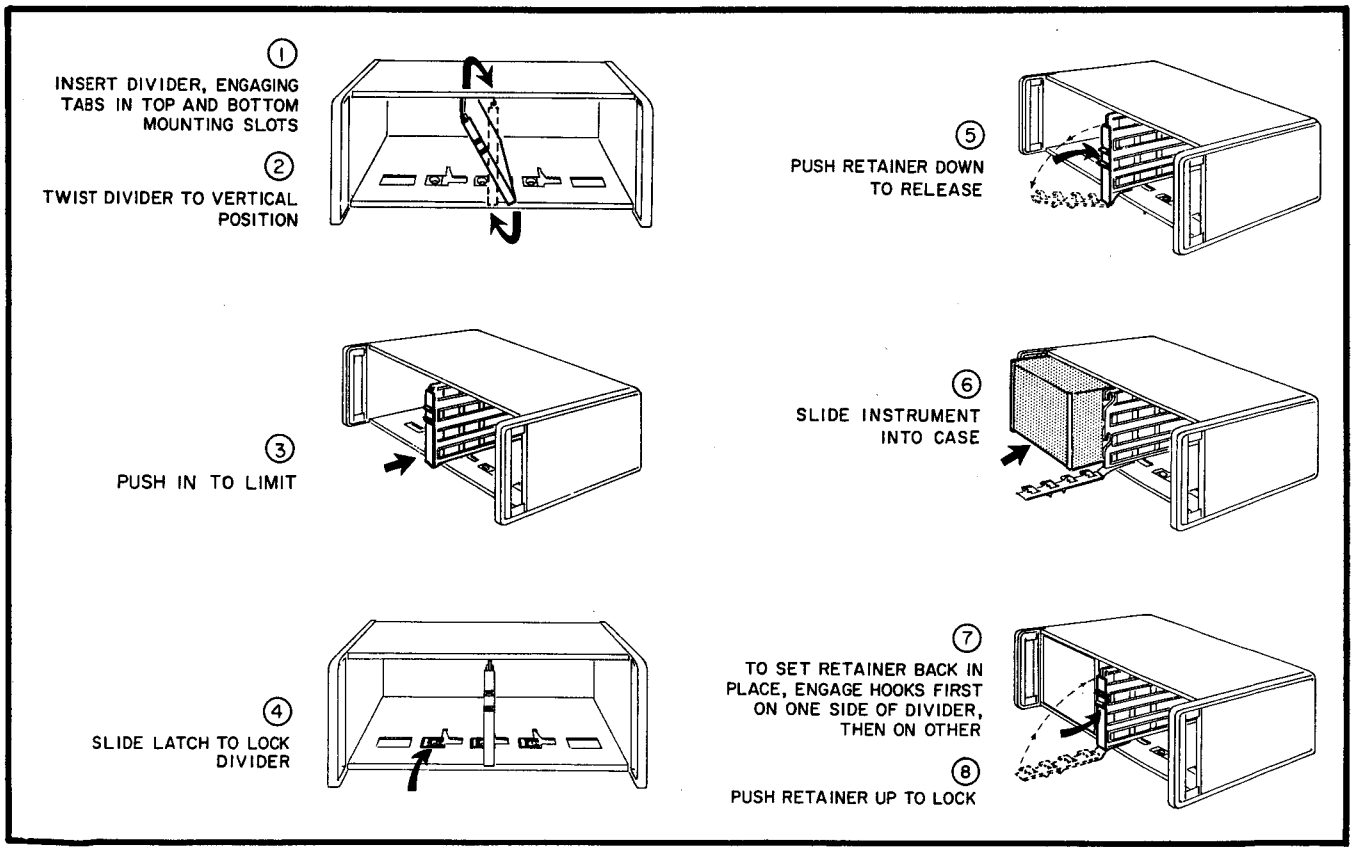


Figure 2-2 Steps to Place Instrument in Combining Case

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL INSPECTION. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken controls or connectors, and dents or scratches on the panel surfaces. If damage is evident, see Paragraph 2-4 for recommended claim procedure and repackaging information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. If the instrument appears undamaged, perform the electrical check given in the following paragraph.

2-3. ELECTRICAL CHECK. Check the electrical performance of the Model 211B as soon as possible after receipt. Paragraph 5-7 through 5-22 contain performance check procedured which will verify instrument operation within the specification listed in Table 1-1. This check is also suitable for incoming quality control inspection. If the Model 211B does not perform within the specifications when received, refer to Paragraph 2-4 for recommended claim procedure and repacking information.

2-4. CLAIMS AND REPACKING.

2-5. If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office (see list at rear of this manual). Refer to inside front cover of this manual for the Warranty statement applicable of all Hewlett-Packard instruments and products. The Sales/Service Office will arrange for repair or replacement of the instrument without waiting for settlement of the claim against the carrier.

2-6. The original shipping carton and packing material, with the exception of the accordian-pleated pads, should be used for reshipment. The accordian-pleated pads are fatiqued with one use and are not reusable. The Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing material is not available or is not reusable. Materials used should include: (1) a double walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces; use extra material around projecting parts of the instrument, (3) at least four inches of tightly-packed shock-absorbing material surrounding the instrument. Close the carton securely with heavy paper tape. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office for repair, attach a tag showing owner, model, serial number and repairs required.

2-7. PREPARATION FOR USE.

2-8. POWER SOURCE REQUIREMENTS. The Model 211B may be operated from an ac source of 115 or 230 volts (+10%, -15%) at 50 to 400 Hz. Power dissipation is approximately 25 watts. With the instrument power cord disconnected, move the slide switch (located on rear panel) until the desired voltage numbers (115 or 230) are visible. A narrow blade screwdriver is recommended to position the slide switch. The instrument power line fuse (located at the rear of the instrument above the power cord receptacle) is a 0.5 ampere, slow-blow type for 115 v. operation and a 0.25 ampere, slow-blow type for 230 v. operation.

2-9. THREE CONDUCTOR POWER CABLE. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument and cabinet be grounded. The centre pin on the power cable is the ground connection. To retain the protection when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to a suitable ground.

2-10. INSTALLATION.

2-11. The Model 211B is fully transistorized; therefore no special cooling is required. However the instrument should not be operated where the ambient temperature exceeds 55° C.

2-12. RACK MOUNTING.

2-13. The Model 211B is a submodular unit that when used alone can be bench mounted only. However when used in combination with other submodular units it can be bench and/or rack mounted. The -hp- combining case and adapter frame are designed specifically for this purpose.

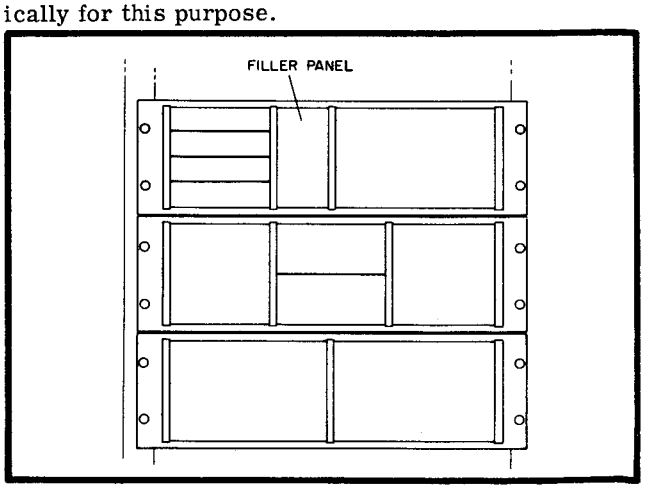


Figure 2-3 Adapter Frame Instrument Combinations

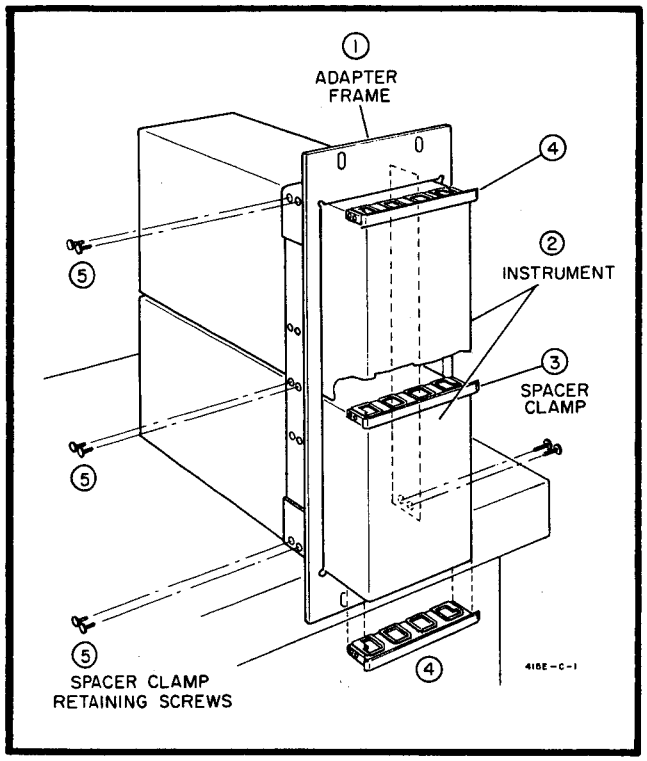


Figure 2-4 Two Half Modules in Rack Adapter

2-14. COMBINING CASE. The combining case is a full-module unit which accepts varying combinations of submodular units. Being a full-module unit, it can be bench or rack mounted analogous to any full module instrument. An illustration of the combining case is shown in Figure 2-1 . Instructions for installing the Model 211B in a combining case are given graphically in Figure 2-2 .

2-15. ADAPTER FRAME. The adapter frame is a rack frame that accepts any combination of sub-modular units. It can be rack mounted only. An illustration of the adapter frame is given in Figure 2-3. To assemble, refer to Figure 2-4 and proceed as follows

a. Place the adapter frame (1) on edge of bench as illustrated.

b. Stack the submodular units (2) in the frame.

c. Place the spacer clamps (3) between instruments.

d. Place the spacer clamps (4) on the two end instruments.

e. Push the combination into the frame.

f. Insert screws (5) on both sides of frame, and tighten until submodular instruments are secure in frame.

g. The complete assemble is ready for rack mounting.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section contains the operating instructions for the Model 211B Square Wave Generator. This instrument has been designed for general purpose laboratory requirements with the ease-of-use as a prime consideration. Therefore the operating procedure is quite simple. Figure 3-2 identifies and briefly describes the pupose of each panel control and connector on the instrument.

3-3. DUTY CYCLE.

3-4. Duty cycle is defined as the ratio of duration of pulse (i.e. pulse width) to the total duration of one complete cycle. Figure 3-1 shows the relationship which determines the duty cycle. The time for one cycle is defined as the period, and the period is related to repetition rate by : $\text{Period} = \frac{1}{\text{Rep. Rate}}$

Thus the product of pulse width and frequency multiplied by 100 determines the duty cycle percentage.

3-5. The SYMMETRY control is responsible for the duty cycle setting; the variability being 25 - 75 % of the period. The duty cycle remains unchanged when external synchronizing signals are applied to the Model 211B.

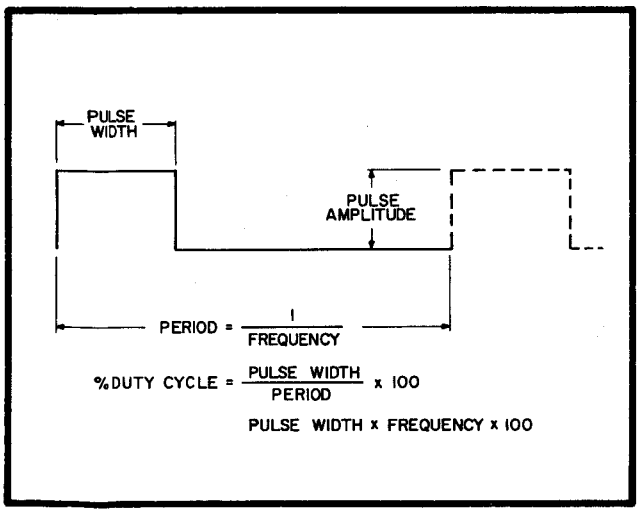


Figure 3-1 Definition of Output Pulse Characteristics

3-6. OPERATING PROCEDURES.

3-7. The Model 211B can be operated in two different modes, free-running or synchronized with external signals. The procedures are detailed in Paragraphs 3-8 through 3-13.

3-8. FREE-RUNNING MODE

3-9. The Model 211B will generate internally any repetition rate from 1 Hz to 10 MHz (1 MHz at 600 Ω output). The repetition rate is established by setting the MULTIPLIER selector to any of the seven internal ranges and then adjusting the FREQUENCY (Hz) control to the specific rate desired.
To operate proceed as follows :

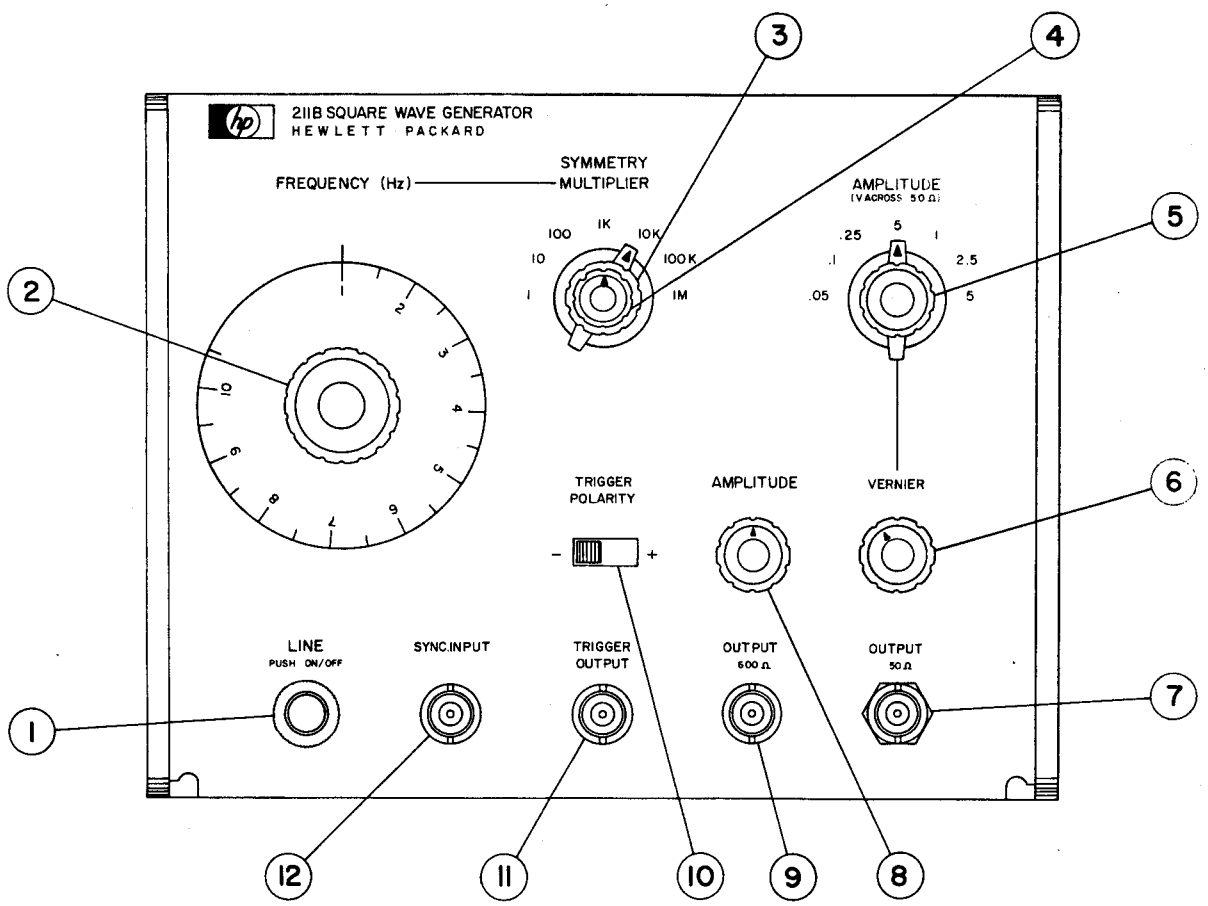
(a) Push instrument LINE switch on.
(b) Set MULTIPLIER to desired range and adjust FREQUENCY (Hz) to exact position for frequency desired.
(c) Adjust SYMMETRY for desired duty cycle.
(d) 50Ω OUTPUT. Select AMPLITUDE range and VERNIER setting desired. Note that the cw position of the VERNIER yields at least that indicated voltage on the AMPLITUDE selector switch.
(e) 600Ω OUTPUT. Adjust AMPLITUDE setting as desired. Note that the specified amplitude is across a 600Ω load. Twice the voltage will be obtained across an open circuit.

3-10 SYNC SIGNALS

3-11. The Model 211B may be synchronized by external signals of either 1 volt positive pulses or 2 V peak to peak sinewaves applied to the SYNC INPUT connector. External signals with frequencies of 105 % to 140 % of the internal setting of the 211B can be synchronized. If the 211B is not in synchronism with an external signal compare dial and range settings with the frequency of the external signal.

3-12. TRIGGER OUTPUT.

3-13. Trigger pulses are available at the front panel of the Model 211B. A positive or negative pulse, selected by TRIGGER POLARITY switch and coincident with the leading edge of the 50Ω output pulse, is available at the trigger output connector.



(1) LINE switch. Controls AC power to instrument and indicates "on" position by glowing red.

(2) FREQUENCY dial. Provides continuous calibrated control of the output frequency within the range determined by the MULTIPLIER setting.

(3) FREQUENCY MULTIPLIER switch. Selects the operating range of the FREQUENCY dial.

(4) SYMMETRY control. Provides adjustment of duty cycle of output pulses.

(5) AMPLITUDE selector switch. Selects amplitude range of the 50Ω output pulse.

(6) AMPLITUDE VERNIER control. Provides continuous adjustment of the 50Ω output pulse between settings of the AMPLITUDE selector switch. Maximum CW position gives at least the voltage shown on the AMPLITUDE selector switch.

(7) OUTPUT-50Ω connector. Supplies 50Ω output pulse.

(8) AMPLITUDE control. Provides uncalibrated control of 600Ω output amplitude.

(9) OUTPUT-600Ω connector. Supplies 600Ω output pulse.

(10) TRIGGER POLARITY switch. Selects either positive or negative TRIGGER OUTPUT pulse.

(11) TRIGGER OUTPUT connector. Supplies trigger output pulse.

(12) SYNC INPUT connector. Input connector for external synchronizing signals.

Figure 3-2 Front Panel Description

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a description of the theory of operation of the -hp- Model 211B Square Wave Generator.

4-3. GENERAL DESCRIPTION.

4-4. The Model 211B comprises of a frequency control network, two current sources, a ramp capacitor network, a Schmitt trigger, a sync circuit, a trigger output circuit and output amplifiers. The complete block diagram is shown in Figure 4-1.

4-5. The Schmitt trigger, current sources, and the ramp capacitor form the basic generating loop. The Schmitt trigger changes state at predetermined limits on the positive and negative slopes of the ramp capacitor output. The effect of the change of state controls the switching circuit which in turn causes the selected ramp capacitor to be charged or discharged. A cycle is as follows: the upper current source charges the ramp capacitor at a linear rate. When the amplitude of the positive slope of the ramp reaches the upper predetermined limit of the Schmitt trigger, the trigger circuit changes state. This change of state activates the switching network, cutting off the upper current source. The discharge continues until the amplitude of the negative slope reaches the lower predetermined limit. At this point the Schmitt trigger reverses to its original state, again activating the switching circuit and so completing one cycle.

4-6. The frequency control network, governed by the FREQUENCY (Hz) dial, determines total current in both sources which, in turn, varies the frequency. An increase or decrease of input current, respectively increases or decreases the rate of charge of the ramp capacitor.

4-7. Operation of the SYMMETRY control varies the ratio of current through the upper and lower current sources effecting a change in the duty cycle, the frequency remaining constant.

4-8. The Schmitt trigger provides square waves to both output amplifiers and for differentiation by the trigger output circuit to produce positive and negative triggering pulses.

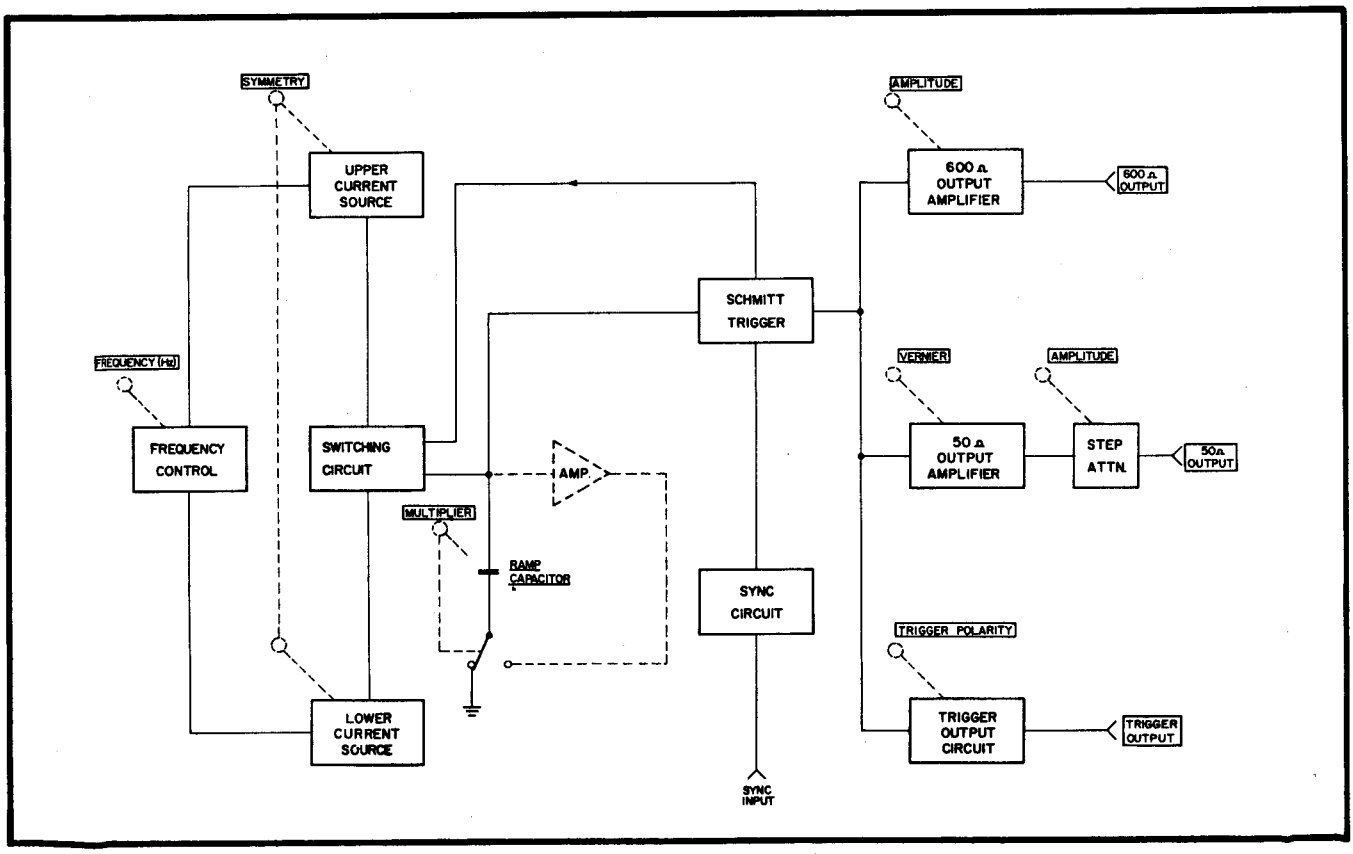


Figure 4-1. Basic Block Diagram.

4-9. SCHEMATIC THEORY.

4-10. FREQUENCY CONTROL NETWORK

4-11. The FREQUENCY dial (R2) in conjunction with the MULTIPLIER switch (S5) provide the frequency control. The basic frequency equation can be expressed as:

$$f = \frac{1}{Ce} \cdot \frac{1}{\frac{1}{i_1} \quad \frac{1}{i_2}}$$

Where i_1 and i_2 are currents from two current sources, C is the ramp capacitor and e is the peak to peak voltage of the triangular waveform across the ramp capacitor.

The position of the MULTIPLIER switch selects the ramp capacitor and the FREQUENCY dial determines the sum of the currents i_1 and i_2. The frequency control voltage is applied to the base of current control transistor Q 11 which establishes the amount of current available to the ramp capacitor from the current sources Q 12 and Q 13.

4-12. CURRENT SOURCES.

Current source transistors Q 12 and Q 13 provide a constant current for charging the ramp capacitor, the ratio of one current to the other is divided between the two sources by the SYMMETRY control. This enables the charge and discharge rate of the ramp capacitor to be controlled hence permitting the duty cycle to be varied with no change in the frequency. (reference Figure 4-2).

4-13. SWITCHING CIRCUIT.

Assume Q20 is conducting and Q21 is cut off. This establishes a base voltage, on the switching circuit transistors, that turns on Q14 and turns off Q15. This action creates two current paths: Current flows through switching transistor Q14 and current source Q12 to the -20 V supply and the ramp capacitor linearly discharges through CR19 and current source Q13. As the voltage at the ramp capacitor is going positive, the base of Q20 is going negative, until the Schmitt trigger changes state. This reverses the operation of the switching circuit, Q14 turns off and Q15 turns on. Current now flows through current source Q13 and switching transistor Q15 to the -20 V supply and current source Q12 linearly charges the ramp capacitor through CR18. The base voltage of Q20 will go positive until the Schmitt trigger switches again.

4-14. RAMP CAPACITOR AMPLIFIER.

On the upper four ranges the ramp capacitors C29-C32 are connected directly to ground. On the lower three ranges C26-C28 and the ramp capacitor amplifier form the ramp capacitor circuit. Q 16 inverts the phase and amplifies the ramp capacitor signal present at the emitter of Q 19. Q 17 and Q 18 provide a low impedance path between the ramp capacitor and ground. The inverted ramp signal applied to the ramp capacitor increases the charging time as shown in Figure 4-3.

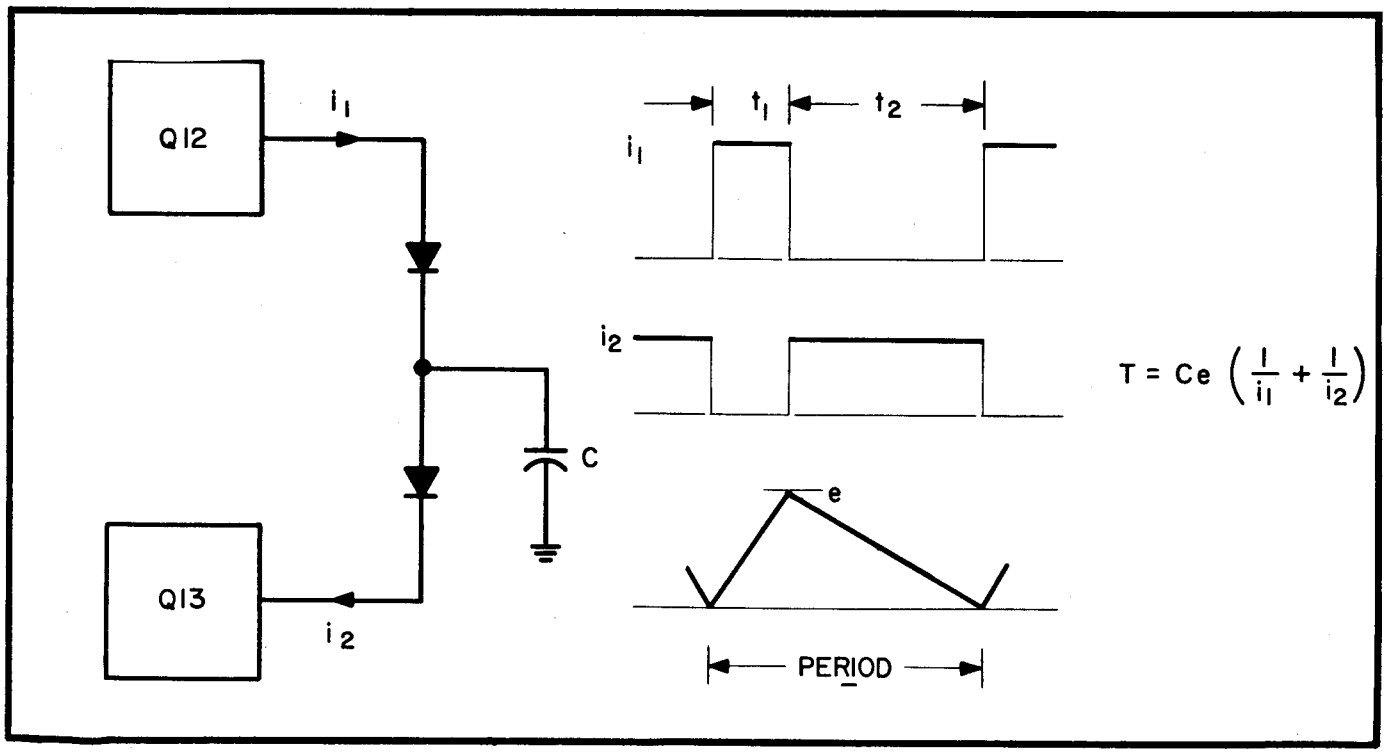


Figure 4-2. Simplified Current Source Operation.

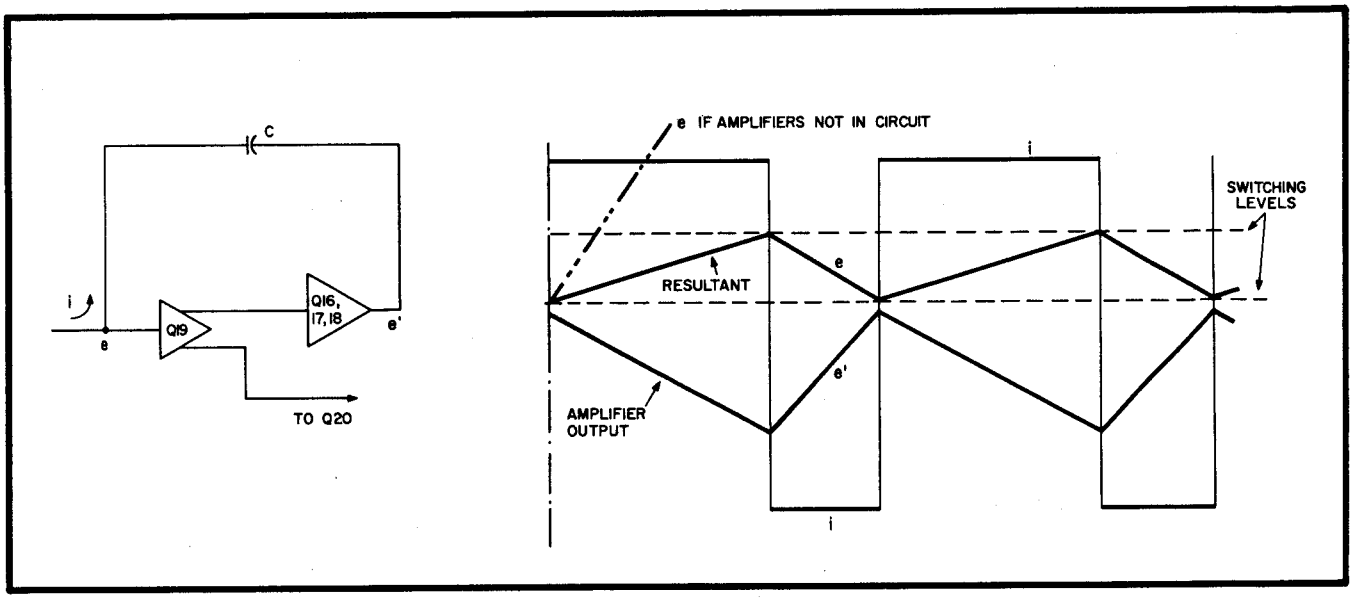


Figure 4-3. Ramp Capacitor Amplifier Block Diagram.

4-15. SCHMITT TRIGGER.

The pulse forming circuit consists of inverter Q 19, Schmitt trigger Q20/Q21 and impedance converter Q 22. Initially Q 20 is conducting and the output from Q 22 is zero. The ramp capacitor voltage is inverted by Q 19 and the negative slope passed to the Schmitt trigger. At a predetermined level (set by circuit components) the Schmitt trigger changes state. The output goes negative, reversing the switching circuit condition and the ramp capacitor charges. The charge continues until the positive going slope on the base of Q 20 switches the Schmitt trigger back to its original state. The output pulse is passed to the trigger output circuit and the 50Ω and 600Ω amplifiers.

4-16. SYNC INPUT CIRCUIT

Four diodes, CR23-CR26, in a bridge configuration limit the maximum amplitude of the input synchronizing signal to approxiamately 4 volts. This signal activates the sync pulse generator Q 23 and Q 24. L1 and CR 29 generate a positive spike which is routed to either Q 25 and Q 26, depending upon the duty cycle setting. The setting is controlled by S 3 which operates in conjunction with the symmetry control. When the duty cycle is below 50% of the period Q 25 is turned on and above 50% Q 26 is turned on. (Synchronization is not possible exactly at 50% duty cycle). By this operation the sync pulse always falls on the long ramp. When this occurs the Schmitt trigger Q 20 and Q 21 changes state and brings the repetition rate into synchronism with the external signal (see Figure 4-4).

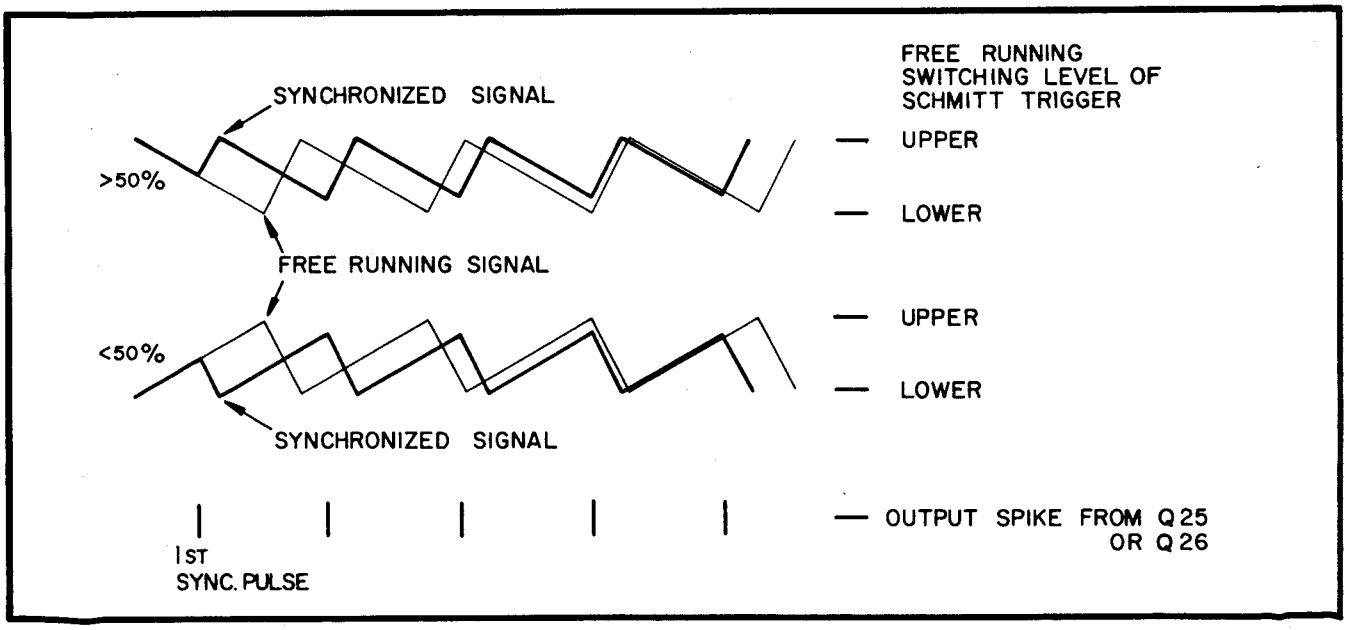


Figure 4-4. Synchronizing Operation.

4-17. TRIGGER OUTPUT CIRCUIT.

C 33 and R 77 differentiate the square wave output of the Schmitt trigger. Q 27 amplifies the signal and provides the negative output trigger pulse. Q 28 inverts the polarity of the spike to provide the positive output trigger pulse.

4-18. 600Ω AMPLIFIER.

Transistors Q 43 through Q 45 and Q3/Q4 amplifier the Schmitt trigger square wave to provide the 600Ω output pulse. A negative output is taken from the collectors of Q3/Q4 and fed through R 6 (AMPLITUDE control) to the output connector. Diode CR 36 functions as a protective device against any inductive load.

4-19. 50Ω OUTPUT

The drivers and output amplifiers Q 37 through Q 42 form the 50Ω output circuit. Voltage source Q 35 and Q 36 regulate the base potentials of driver transistors Q 39 and Q 42 to provide the AMPLITUDE VERNIER control. Output attenuator A 1 provides step attenuation of the negative 50Ω output pulse.

4-20. POWER SUPPLY.

The power supply operates from either 115 or 230 V ac which is rectified and regulated to provide dc output of -20 V, -70 V and +6.8 V. Two seperate primary windings of transformer T 1 are switched by S 2, in parallel for 115 V operation or in series for 230 V operation. The -20 V and -70 V supplies operate in a similar manner. Error amplifier transistors Q 5 or Q 8 sense and amplify any change in output voltage. The change is applied through regulator control transistor Q 6 and Q 7 to series regulators Q 1 and Q 2 which act as variable series resistors in the circuitry path. Diode CR 10 in the -70 V supply limits the initial voltage across Q 2. The +6.8 V supply is filtered by R 20 and C 14 and regulated by zener diode and CR 9.

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the Model 211B Square Wave Generator. Performance check, adjustment procedures, troubleshooting, and repair and replacement information are the major areas covered in this section. Component location and schematic diagrams are also included at the rear of the section.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 211B is listed in Table 5-1. Test equipment having characteristics similar to those listed in the table may be substituted for the performance check and adjustments.

5-5. INSTRUMENT COVER REMOVAL.

5-6. The top, bottom, and side covers are seperately removable. Each cover is held in place by screws which thread into fasteners attached to the instrument side castings. Removal of the top cover provides access to all components and test points on etched circuit boards and to nearly all other components on front panel assemblies. Always remove instrument covers with the AC power turned off or power cord removed.

5-7. PERFORMANCE CHECK.

5-8. The performance check verifies whether or not the Model 211B is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check. Performance checks must be carried out in the sequence given below.

5-9. REPETITION RATE

a. Refer to Figure 5-2 and Table 5-1 and connect required equipment

b. Set Model 211B controls as follows:

MULTIPLIER..... 1
FREQUENCY Dial..... 1
SYMMETRY.....50% duty cycle
AMPLITUDE (V across 50Ω)..5
VERNIER.....CW

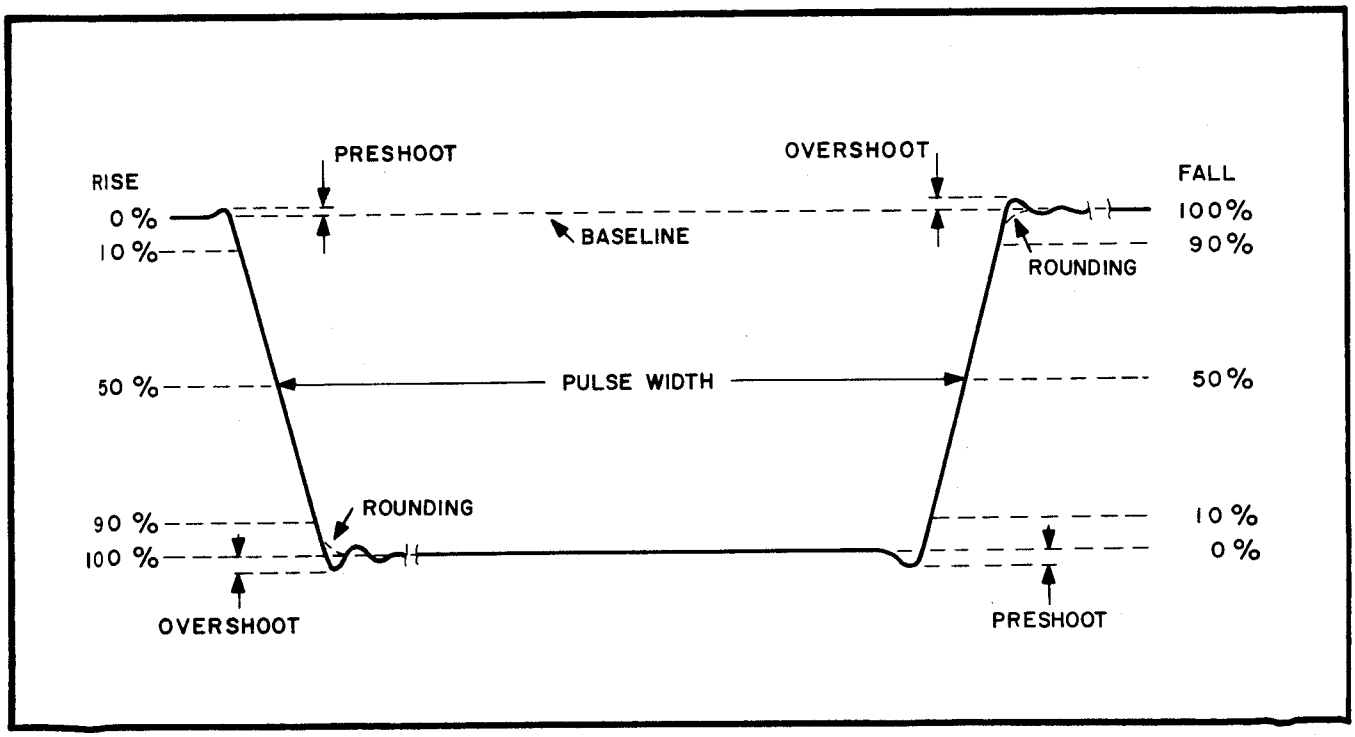


Figure 5-1. Definition of Output Pulse Characteristics

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Required for
Type	Model		
Sampling Oscilloscope	hp 185B with 187C	1 GHz Bandwidth	Performance Check
High Frequency Oscilloscope	hp 175A with 1755A and 1781B	50 MHz Bandwidth 50 mV/cm Sensitivity	Performance Check
10:1 Divider	hp 10214A	1 GHz Bandwidth	Performance Check
50Ω Tee	hp 410221A	1 GHz Bandwidth	Performance Check
50Ω Attenuator	Weinschel Model 50-20-S	Use Recommended Equipment	Performance Check
50Ω Load	hp 11048B		Performance Check
50Ω Termination	GR 874-W50	1 GHz Bandwidth	Performance Check
600Ω Load			Performance Check
BNC Adapter	hp 10110A	BNC male to Binding Post	Performance Check
Test Oscillator	hp 651A	1 Hz to 10 MHz 3 V Output Range	Performance Check
AC Voltmeter	hp 403B	0.003 V to 0.03 V Voltage Range	Adjustments and Troubleshooting
DC Voltmeter	hp 412A	3 V to 100 V Voltage Range	Adjustments and Troubleshooting

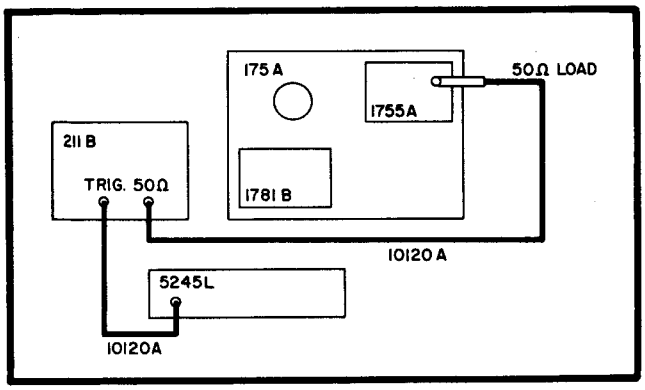


Figure 5-2. Dial Accuracy Check

c. Set Electronic Counter controls as follows:

SIGNAL INPUT..... AC
SENSITIVITY.....0.1 V
TIME BASE .....0.1μ sec.
FUNCTION.....1 Period Average

d. Electronic Counter should read 1 000 000μs ±50 000μs

e. Set FREQUENCY Dial to 5, Electronic Counter should read 200 000μs ±10 000μs

f. Set FREQUENCY Dial to 10, Electronic Counter should read 100 000μs ±5 000μs

g. Set MULTIPLIER to 10 and FREQUENCY Dial to 1, Electronic Counter should read 100 000μs ±5 000μs

h. Repeat steps e and f with MULTIPLIER at 10,Electronic Counter should read 20 000μs ±1000μs and 10 000μs ±500μs respectively.

i. Set MULTIPLIER to 100 and FREQUENCY Dial to 1, Electronic Counter should read 10 000μs ±500μs

j. Repeat steps e and f with MULTIPLIER at 100, Electronic Counter should read 2 000μs ±100μs ±500μs respectively.

k. Set Electronic Counter FUNCTION to FREQUENCY and TIMEBASE to 1 sec.

l. Complete check by setting Square Wave Generator MULTIPLIER switch and FREQUENCY Dial as shown in Table 5-2 columns one and two. The Electronic Counter reading should be as shown in column three.

Table 5-2. Dial Accuracy

MULTIPLIER SWITCH	FREQUENCY DIAL	COUNTER READING
1K	1	1000Hz ±50Hz
1K	5	5000Hz ±250Hz
1K	10	10KHz ±500Hz
10K	1	10KHz ±500Hz
10K	5	50KHz ±2.5KHz
10K	10	100KHz ±5KHz
100K	1	100KHz ±5KHz
100K	5	500KHz ±25KHz
100K	10	1000KHz ±50KHz
1M	1	1000KHz ±50KHz
1M	5	5000KHz ±250KHz
1M	10	10000KHz ±500KHz

5-10. SYMMETRY CONTROL CHECK

a. With Model 211B connected as shown in Figure 5-2, set the controls as follows:

MULTIPLIER..... 10K
FREQUENCY Dial..... 1
SYMMETRY..... CW
AMPLITUDE (v across 50Ω).. 5
VERNIER..... CW

b. Set oscilloscope controls as follows:

TIME SCALE..... 20μs/cm
TIME SCALE MAGNIFIER....X1
TRIGGER SOURCE.....internal
SWEEP SELECTOR.....main sweep
CHANNEL SELECTOR.....channel A
SENSITIVITY..... 2 V/cm dc coupled
POLARITY..... positive

c. Adjust oscilloscope for a stable display

d. The "on time" should be greater than 75% of the period.

e. Turn the SYMMETRY control CCW and the "on time"should be less than 25% of the period.

5-11. OUTPUT PULSE CHARACTERISTICS.

5-12. Refer to Figure 5-1 for definition of pulse characteristics. Follow these procedures in sequence since each paragraph continues the same equipment connections and front panel settings as in the proceeding paragraph. Any required changes in control settings are specified in the procedures. All measurements are made with a 10:1 divider.

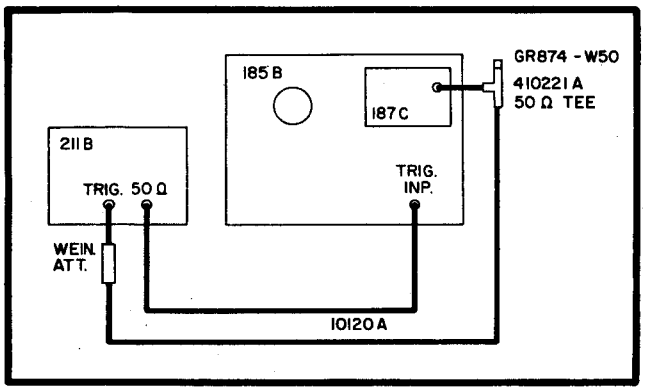


Figure 5-3. 50Ω Output Pulse Check

5-13. 50Ω OUTPUT

5-14. Pulse Amplitude

a. Refer to Figure 5-3 and connect required equipment.

b. Set Model 211B controls as follows:

MULTIPLIER.....1M
FREQUENCY DIAL 1
SYMMETRY..... 50% duty cycle
AMPLITUDE (v across 50Ω)..5
VERNIER.....CCW
TRIGGER POLARITY.....negative

c. Set Sampling Oscilloscope controls and plug-in as follows:

TIME SCALE..... 200ns/cm
VERNIER..... CAL
TIME SCALE MAGNIFIER... X1
TRIGGERING..... normal
TRIGGER SLOPE..... negative
MODE AND STABILITY.....for stable trace
CHANNEL SELECTOR.....channel A
SENSITIVITY..... 50mV/cm
VERNIER..... CAL
RESPONSE..... normal

d. The oscilloscope display should be no more than 4 cm (2 V) in amplitude. If 4 cm or less is observed the ratio between CW and CCW is at least 2.5 to 1. Therefore at a 0.05 V pulse amplitude setting the minimum of 0.025 V output can be obtained.

5-15. Pulse shape

a. Set Oscilloscope TIME SCALE to 20ns/cm.

b. Set Model 211B FREQUENCY dial to 5, set AMPLITUDE (V across 50Ω) switch to 5 and adjust VERNIER for a pulse amplitude of 5 V (10cm).

c. Change the time scale MAGNIFIER to X20. Move the leading edge of the pulse to the center of the graticule.

f. The following leading edge characteristics should be observed.

Rise Time 10% to 90%...No more than 5 cm (5ns)
Preshoot..... No more than 5 mm (5%)
Overshoot and Ringing.. No more than 5 mm peak (5%)

g. Adjust Oscilloscope DELAY control for display of pulse trailing edge.

h. The following trailing edge characteristics should be observed

Fall Time 10% to 90%...No more than 5 cm (5ns)
Preshoot..... No more than 5 mm (5%)
Overshoot and Ringing.. No more than 5 mm peak (5%)

5-16. 600Ω OUTPUT

5-17. Pulse Amplitude

a. Refer to Figure 5-4 and connect required equipment.

b. Set Model 211B controls as follows:

MULTIPLIER.....10K
FREQUENCY DIAL.....10
SYMMETRY..... 50% duty cycle
AMPLITUDE - 600Ω.....CW

c. Set High Frequency Oscilloscope and plug-in's as follows:

SWEEP TIME.....2μs/cm
VERNIER..... CAL
HORIZONTAL DISPLAY.....X1
VERNIER..... CAL
TRIGGER SOURCE..... internal
TRIGGER SLOPE..... negative
CHANNEL SELECTOR.....channel A
SENSITIVITY.....1 V/cm - dc
VERNIER..... CAL
POLARITY..... positive
SWEEP SELECTOR..... main

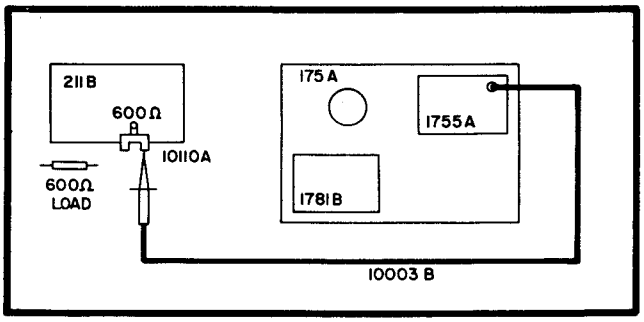


Figure 5-4. 600Ω Output Pulse Check

d. Adjust AMPLITUDE control for a pulse amplitude of 60 V (6cm). The overshoot should be less than 3 mm (5%).

e. Connect a 600Ω load across the output. The pulse amplitude should be at least 30 V (3cm).

f. Set Oscilloscope plug-in SENSITIVITY to 0.01 V/cm and adjust AMPLITUDE control for 0.3 V (3cm). The overshoot should be less than 3 mm (5%).

5-18. Rise and Fall Times

a. Set the Oscilloscope SWEEP TIME to 0.2μs/cm and SENSITIVITY to 1V/cm.

b. Move the leading edge of the pulse to the center of the CRT. Set HORIZONTAL DISPLAY to X10. Check rise time between 10% and 90% amplitude points. It should be less than 7 cm (140ns).

c. Change the Oscilloscope TRIGGER SLOPE to positive and move the trailing edge of the pulse to the center of the CRT. Check fall time between the 10% and 90% amplitude points. It should be less than 7 cm (140ns).

d. Connect the Model 211B output to a 600Ω load.

e. Set the Oscilloscope plug-in SENSITIVITY to 0.5 V. Check the fall time between 10% and 90% amplitude points. It should be less than 3.5 cm (70ns)

f. Change the Oscilloscope TRIGGER SLOPE to negative and move the leading edge of the pulse to the center of the CRT. Check rise time between 10% and 90% amplitude points. It should be less than 3.5 cm (70ns). Remove the 600Ω load.

5-19. SYNCHRONIZATION

5-20. This procedure will verify that the Model 211B is capable of synchronizing with an external trigger input of at least 1 V peak or 2 V rms at frequencies slightly higher than the set repetition rate.

a. Refer to Figure 5-5 and connect required equipment.

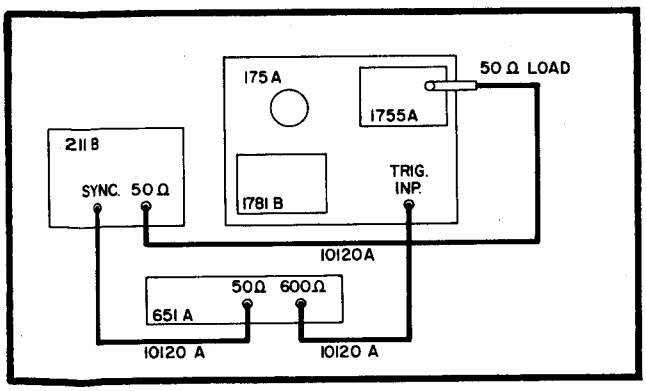


Figure 5-5. External Pulse Synchronization

b. Set Model 211B controls as follows:

MULTIPLIER.....1K
FREQUENCY DIAL.....10
SYMMETRY..... CCW
AMPLITUDE (across 50Ω)..5 V
VERNIER.....CW

c. Set Oscilloscope and plug-in controls as follows:

SWEEP TIME.....5μs/cm
HORIZONTAL DISPLAY.....X1
VERNIER..... CAL
TRIGGER SOURCE..... external
SWEEP SELECTOR..... main sweep
CHANNEL SELECTOR..... channel A
SENSITIVITY..... 2 V/cm dc
VERNIER..... CAL

d. Set Test Oscillator controls as follows:

RANGE.....X10K
FREQUENCY DIAL.....1.1
OUTPUT ATTENUATOR..... 3 V
AMPLITUDE 50Ω..... 2 V pk to pk

e. Adjust Oscilloscope sweep time VERNIER for a full graticule period (10cm).

f. Turn 651A FREQUENCY Dial slowly CCW until a half graticule period (5cm) is obtained.

g. Turn the Model 211B SYMMETRY control slowly CW and observe the 180° phase shift at 50% duty cycle.

5-21. TRIGGER OUTPUT

5-22. This procedure verifies the Trigger Output characteristics of the Model 211B. Refer Figure 5-6 for connection.

a. Set Model 211B controls as follows:

MULTIPLIER.....1M
FREQUENCY DIAL.....5
AMPLITUDE (5v across 50Ω).5
VERNIER.....CW
TRIGGER POLARITY.....negative

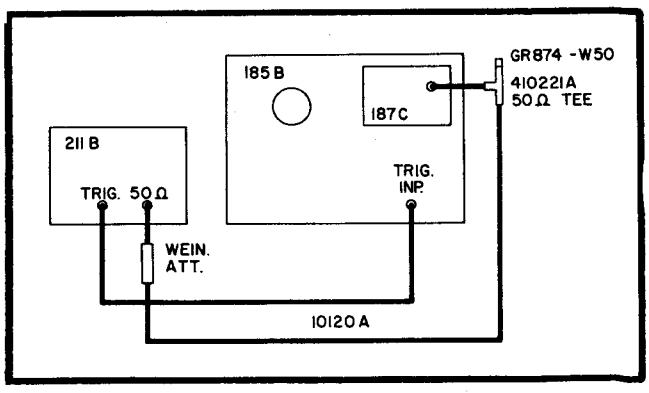


Figure 5-6. Trigger Output Pulse Check

b. Set Sampling Oscilloscope controls as follows:

TIME SCALE..... 20ns/cm
VERNIER..... CAL
TIME SCALE MAGNIFIER....X2
CHANNEL SELECTOR.....Channel A
SENSITIVITY..... 50mV/cm

c. Move the trigger pulse to the center of the CRT. The pulse amplitude should be 2 V or more.

d. Adjust Oscilloscope plug-in sensitivity VERNIER for a full screen picture. Observe the pulse width at 50% amplitude points. The pulse width should be 10ns (1 cm).

e. Change Model 211B TRIGGER POLARITY switch to positive. Pulse should be positive and same specifications as in steps c and d apply.

5-23. POWER SUPPLY

5-24. If the power supply circuits are inoperative, check the power cord connection and line fuse F 1. Refer to the schematic for other components in the ac portion of the power supply circuit. All dc voltage measurements, typical values indicated on the schematic, should be made with respect to chassis ground. Adjustments can be made after the top cover of the 211B has been removed.

a. Adjust R18 for -20 V

b. Adjust R26 for -70 V

5-25. TROUBLESHOOTING

5-26. To locate trouble in the 211B, start with a thorough visual inspection and then proceed to electrically check out as necessary. During the visual inspection look for burned or loose components, loose wire connections, or any other similar condition which suggests a source of trouble. Repair any faulty component or connection that is isolated during the visual inspection and check instrument performance before continuing to troubleshoot the instrument.

5-27. If no obvious fault is located during the visual inspection proceed with the electrical check out. Use the block diagrams in Section IV as an aid in isolating the trouble to a particular circuit.

5-28. REPAIR AND REPLACEMENT

5-29 Repair of the Model 211B consists basically of replacing defective components located during troubleshooting. The following paragraphs provide information on the identification and location of all components in the Model 211B, and basic considerations when repairing etched circuit boards. If satisfactory operation or repair cannot be accomplished, contact your nearest Hewlett-Packard Sales/Service Office (adresses given at rear of this manual). If shipment of the instrument to the Sales/Service Office for repair is recommended, refer to Paragraph 2-4 for repackaging information. Refer to Section VI for part numbers of replaceable parts and ordering instructions.

5-30. COMPONENT IDENTIFICATION.

5-31. All electrical components in the Model 211B are identified on the schematics with a reference designation. Location of components mounted on etched circuit boards or switches is provided in the component location figures. All electrical components not mounted on etched circuit boards or switches are identified in Figure 5-10.

5-32. To help with proper replacement of semiconductors, the emitter or cathode connection is identified by a small dot etched on the circuit board beside the connection point.

5-33. SERVICING ETCHED CIRCUIT BOARDS.

5-34. The Model 211B has etched circuit boards which are plated-through type. When servicing this type of board, components may be removed or replaced by unsoldering from either side of the board. When removing large components, such as potentiometers, rotate the soldering iron tip from lead to lead while applying pressure to the part to lift it from the board. Service Note M-20D contains additional infirmation on the repair of etched circuit boards, however, the important considerations are as follows:

a. Do not apply excessive heat.

b. Apply heat to component lead and remove lead with a straight pull away from board.

c. Use toothpicker or wooden splinter to clean hole.

d. Do not force leads of replacement component into holes.

5-35. If the plated metal surface (conductor) lifts from the board, it may be cemented back with a quick-drying acetate base cement (use sparingly) having good insulating properties. An alternate method of repair is to solder a good conducting wire along the damaged area.

Table 5-3. Schematic Diagram Notes

Refer to MIL-STD-15-1 for schematic symbols not listed in this table.

Unless otherwise indicated:
capacitance in μF
inductance in μH
resistance in Ω

 = Etched circuit board

 = Front panel marking

 = Rear panel marking

 = Front panel control

 = Screwdriver Adjustment

CW = Clockwise end of variable resistor; blue disk potentiometers viewed from center (wiper) arm connection side.

 = Primary signal path

 = Feedback path

 = Waveform test point (with number)

 = Common point (with letter)

 = Avalanche (zener) diode

 = Tunnel diode

 = Step recovery diode

 = Silicon controlled rectifier

Numbers in parentheses indicate wire color using resistor color code, e.g. WHT-RED-GRN is (9·2·5).

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

P/O = Part of

* = Optimum value selected at factory, average value shown; part may have been omitted

N.C. = No connection

DC Voltage Measurement Conditions:

MULTIPLIER. 1K
FREQUENCY. 10
SYMMETRY. 50%
AMPLITUDE (V across 50Ω). 5
VERNIER. . . . . 10 V (open circuit)
AMPLITUDE. . . . . Fully CW

All measurements taken with -hp- 412A.

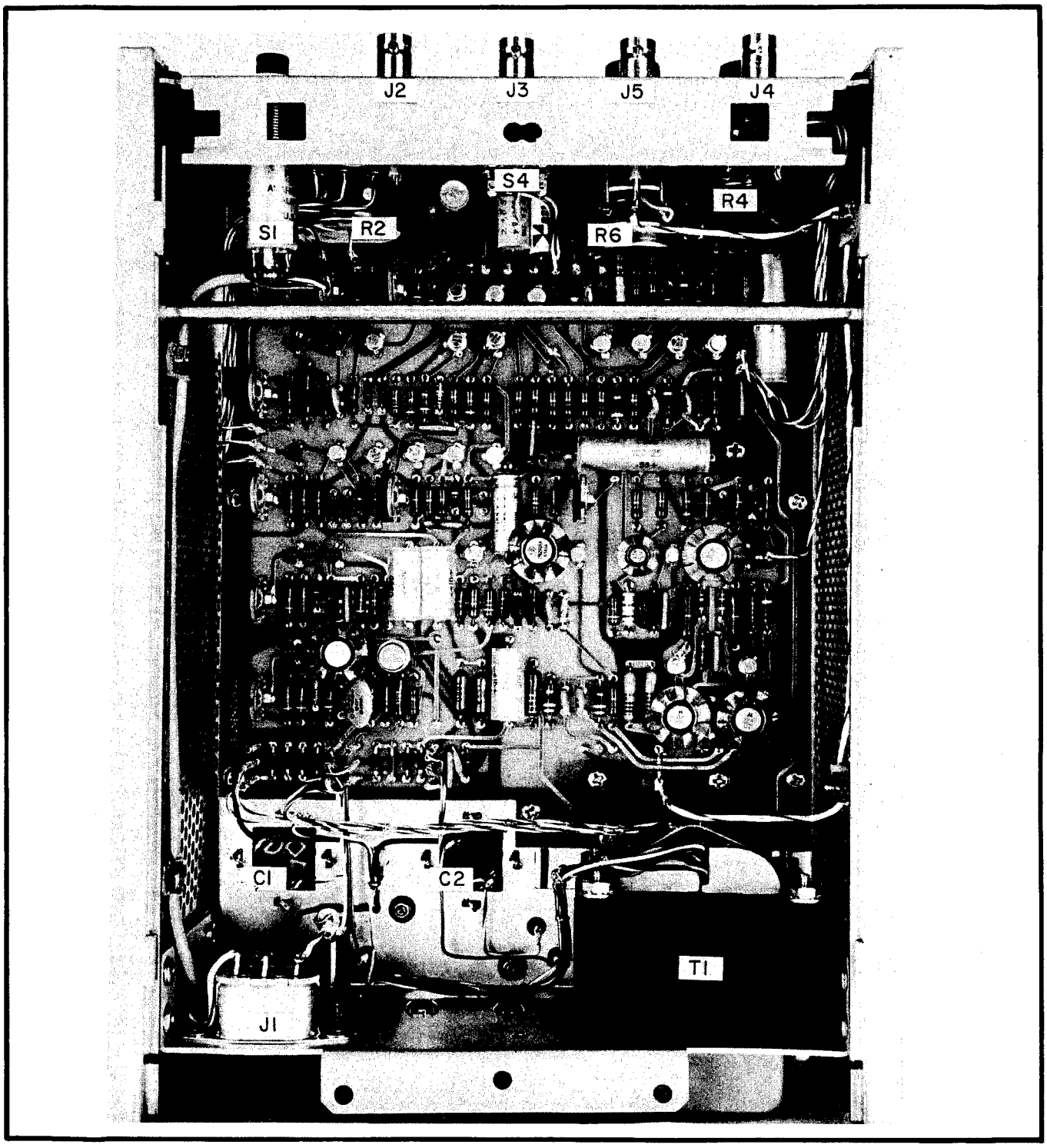


Figure 5-7. Component Location on A2 Board

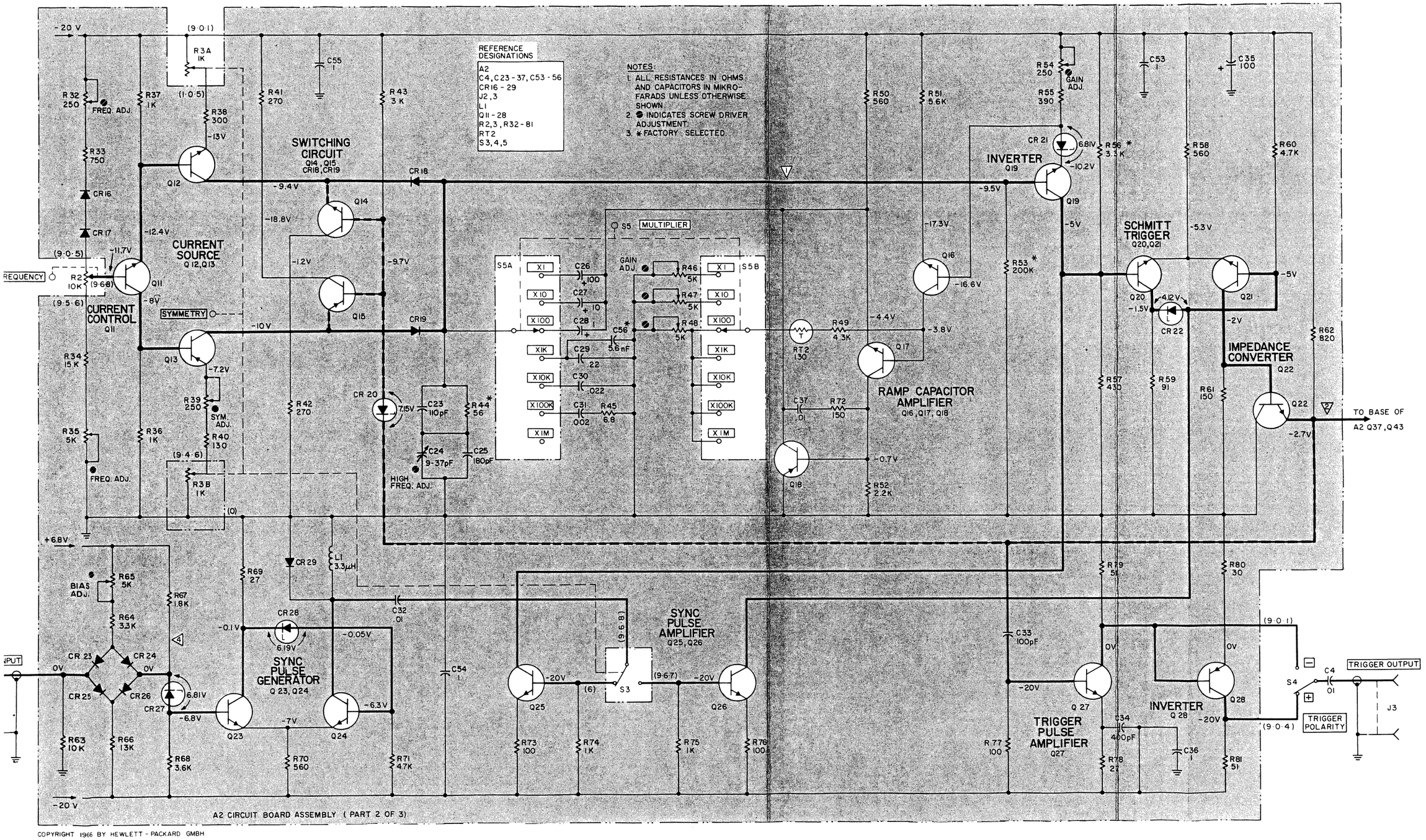


Figure 5-8. Repetition Rate. Synchronizing and Trigger Output Circuit Schematic Diagram

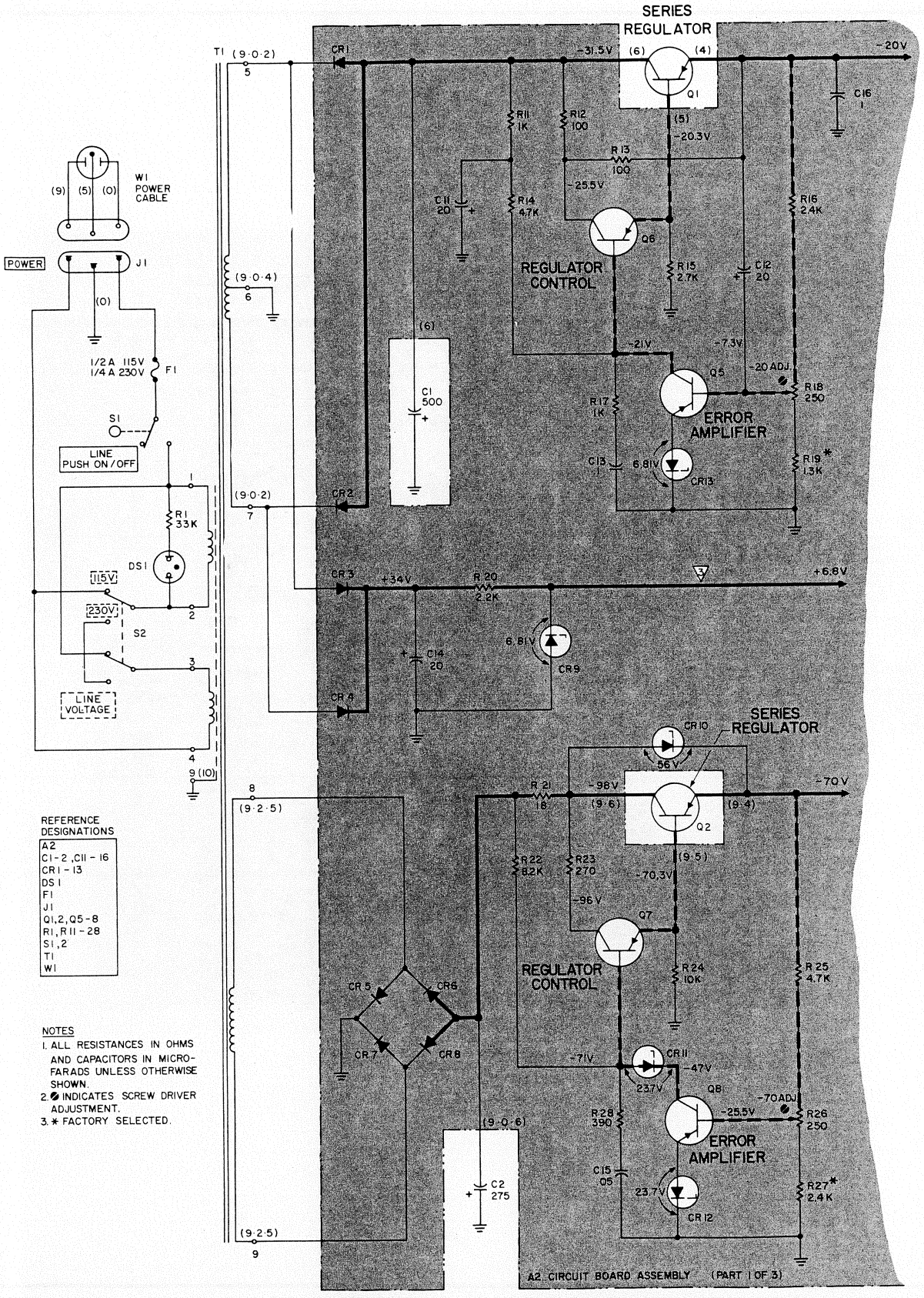


Figure 5-9. Power Supply Circuit Schematic Diagram

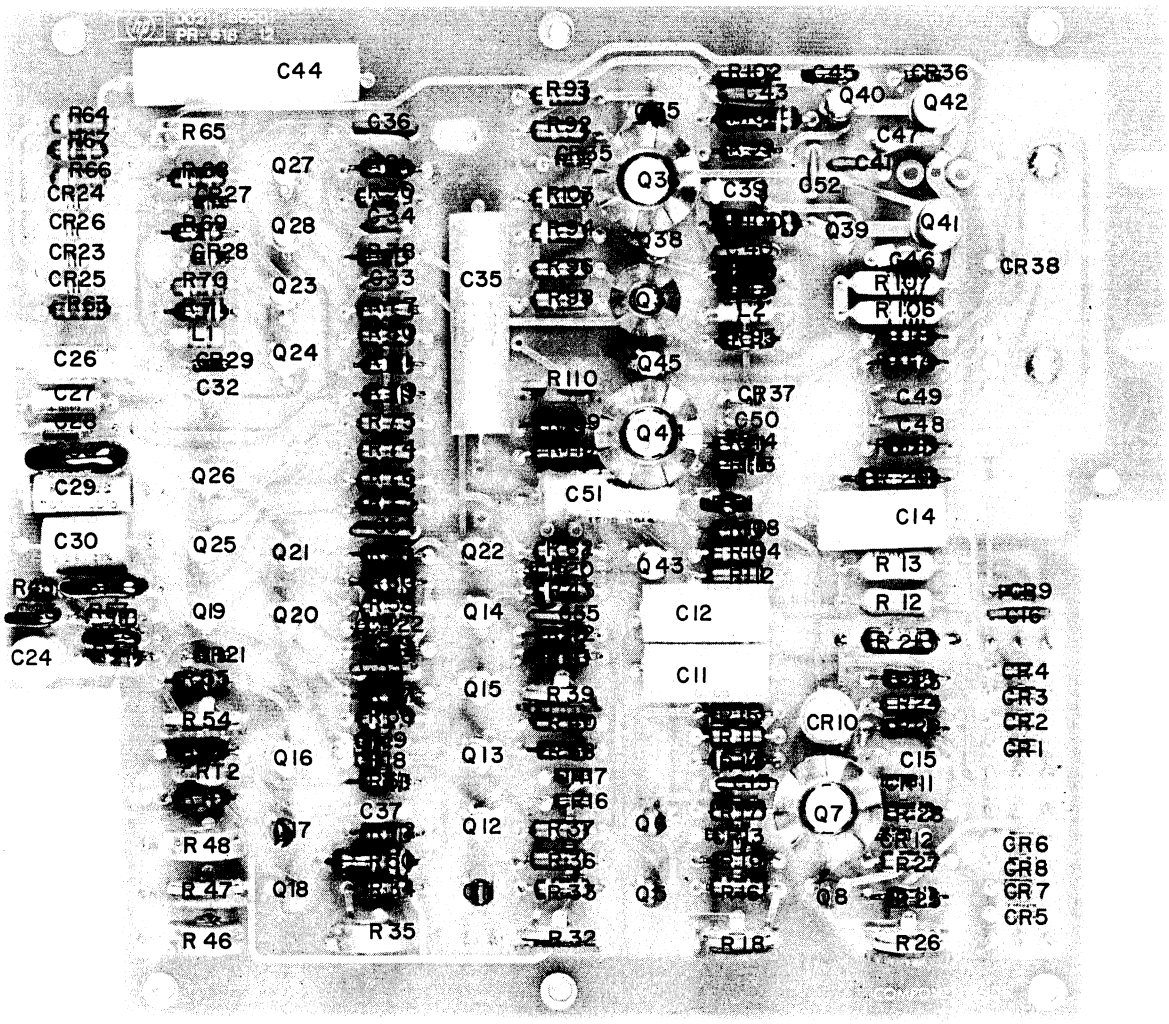
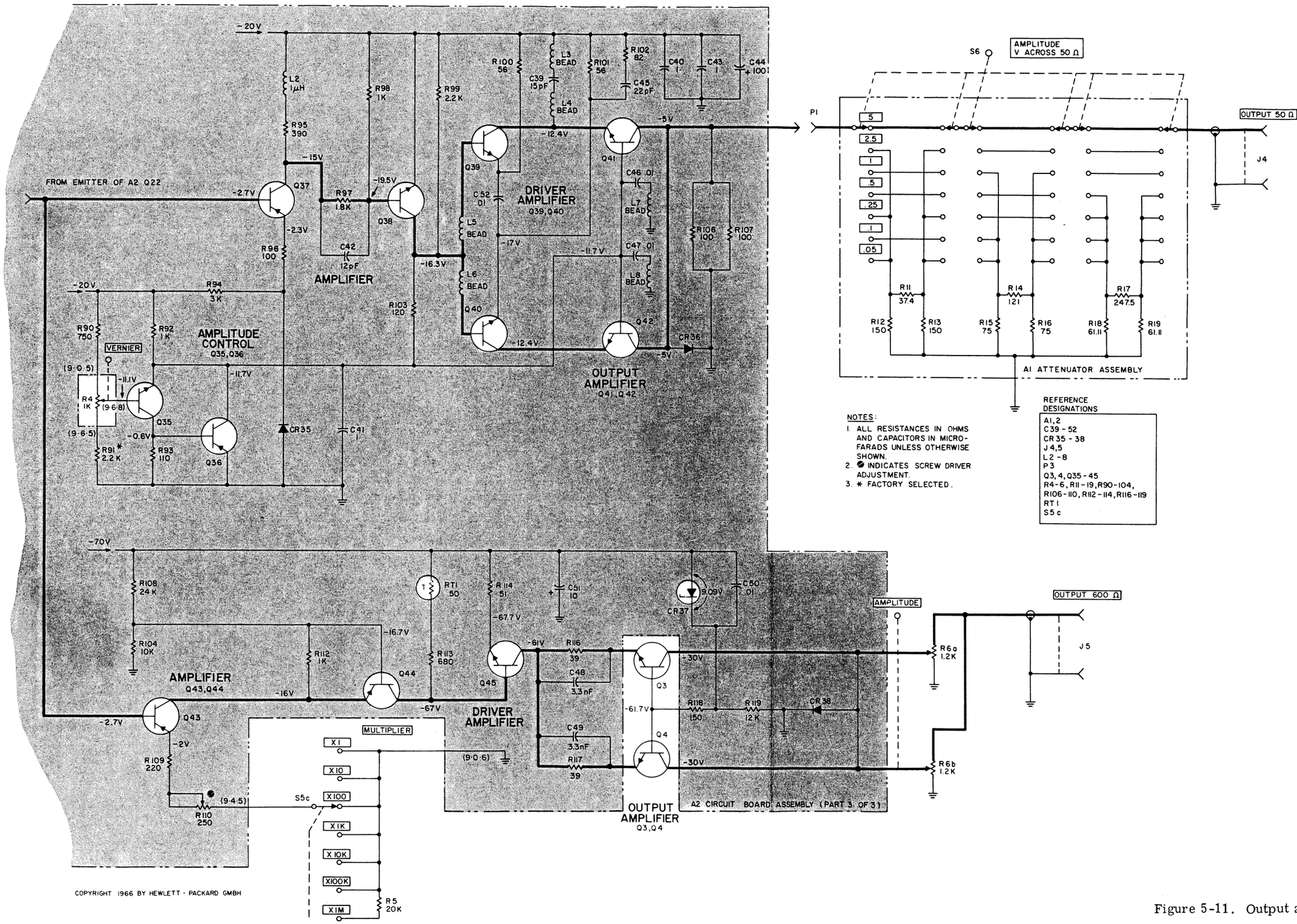


Figure 5-10. Component Location, top view



NOTES:
1. ALL RESISTANCES IN OHMS AND CAPACITORS IN MICROFARADS UNLESS OTHERWISE SHOWN.
2. ◉ INDICATES SCREW DRIVER ADJUSTMENT.
3. * FACTORY SELECTED.

REFERENCE DESIGNATIONS

A1, 2
C39 - 52
CR35 - 38
J4, 5
L2 - 8
P3
Q3, 4, Q35 - 45
R4-6, R11-19, R90-104, R106-110, R112-114, R116-119
RT1
S5c

Figure 5-11. Output and Attenuator Circuits Schematic Diagram

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ⓗ stock numbers and provides the following information on each part:

a) Description of the part (see list of abbreviations below)

b) Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c) Manufacturer's stock number.

d) Total quantity used in the instrument (TQ column).

e) Recommended spare part quantity for complete maintenance (RS column) during one year of isolated service.

6-3 Miscellaneous parts not indexed in table 6-1 are listed at the end of table 6-2.

6-4 ORDERING INFORMATION

6-5 To order a replacement part, address order of inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S.A.
54 Route des Acacias
Geneva, Switzerland

6-6 Specify the following information for each part:

a) Model and complete serial number of instrument.

b) Hewlett-Packard stock number.

c) Circuit reference designator.

d) Description

6-7 To order a part not listed in tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor		
C	= capacitor	J	= jack	R	= resistor	W	= cable
CR	= diode	K	= relay	RT	= thermistor	X	= socket
DL	= delay line	L	= inductor	S	= switch	Y	= crystal
DS	= device signaling (lamp)	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

A	= amperes	F	= farads	NC	= normally closed	S-B	= slow-blow
BP	= bandpass	FXD	= fixed	NE	= neon	SE	= selenium
BWO	= backward wave oscillator			NO	= normally open	SECT	= section(s)
		GE	= germanium	NPO	= negative positive zero (zero temperature coefficient)	SI	= silicon
CER	= ceramic	GL	= glass			SIL	= silver
CMO	= cabinet mount only	GRD	= ground(ed)			SL	= slide
COEF	= coefficient					SPL	= special
COM	= common	H	= henries	NSR	= not separately replaceable		
COMP	= composition	HG	= mercury			TA	= tantalum
CONN	= connection	HR	= hour(s)			TD	= time delay
CRT	= cathode-ray tube					TI	= titantium dioxide
		IMPG	= impregnated	OBD	= order by description	TOG	= toggle
DEPC	= deposited carbon	INCD	= incandescent	OX	= oxide	TOL	= tolerance
		INS	= insulation(ed)			TRIM	= trimmer
EIA	= Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗ stock numbers.					TWT	= traveling wave tube
		K	= kilo = 1000	P	= peak		
				PC	= printed circuit board	U	= micro $=10^{-6}$
		LIN	= linear taper	PF	= picofarads = 10^{-12} farads	VAC	= vacuum
		LOG	= logarithmic taper			VAR	= variable
				PP	= peak-to-peak	W/	= with
		MEG	= meg $=10^{6}$	PIV	= peak inverse voltage	W	= watts
		M	= milli $=10^{-3}$	POR	= porcelain	WW	= wirewound
		MINAT	= minature	POS	= position(s)	W/O	= without
		METFLM	= metal film	POLY	= polystyrene		
		MFR	= manufacturer	POT	= potentiometer		
		MOM	= mounting			*	= optimum value selected at factory, average value shown (part may be omitted)
		MTG	= momentary	RECT	= rectifier = rotary		
ELECT	= electrolytic	MY	= mylar	RMS	= root-mean-square		
ENCAP	= encapsulated			RMO	= rack mount only		

Table 6-1. Reference Designation Index

Reference Designation	-hp-Stock No.	Description #
A1	00211-63401	ATTENUATOR ASSEMBLY, INCLUDES
		R11 thru R19 and S6
A1R11	0757-0172	R: FXD MET FLM 37.4Ω 1% 1/2 W
A1R12 and A1R13	0757-0801	R: FXD MET FLM 150Ω 1% 1/2 W
A1R14	0757-0069	R: FXD MET FLM 121Ω 1% 1/4 W
A1R15 and A1R16	0757-0795	R: FXD MET FLM 75Ω 1% 1/2 W
A1R17	0757-0071	R: FXD MET FLM 247.5Ω 1% 1/4 W
A1R18 and A1R19	0757-0067	R: FXD MET FLM 61.11Ω 1% 1/2 W
A1S6		SWITCH, ATTENUATOR NSR PART OF A1 ASSEMBLY
A2	00211-66501	PRINTED CIRCUIT BOARD
A2C1 thru A2C10		NOT ASSIGNED
A2C11 and A2C12	0180-0049	C: FXD AL ELECT 20μF 50VDCW
A2C13	0150-0121	C: FXD CER 0.1μF +80% -20% 50VDCW
A2C14	0180-0049	C: FXD AL ELECT 20μF 50VDCW
A2C15	0150-0096	C: FXD CER 0.05μF ±20% 100VDCW
A2C16	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2C17 thru A2C22		NOT ASSIGNED
A2C23	0140-0194	C: FXD MICA 110pF 5% 300VDCW
A2C24	0121-0046	C: VAR CER 9-35pF
A2C25	0140-0147	C: FXD MICA 180pF 5% 500VDCW
A2C26	0180-0137	C: FXD TA ELECT 100μF 20% 10VDCW
A2C27	0180-0374	C: FXD TA ELECT 10μF ±10% 20VDCW
A2C28	0180-0291	C: FXD TA ELECT 1μF 10% 35VDCW
A2C29	0160-0503	C: FXD MET PAPER 0.22μF 2% 160VDCW
A2C30	0160-0502	C: FXD MYLAR 22nF 1% 60VDCW
A2C31	0140-0180	C: FXD MICA 2000pF 2% 300VDCW
A2C32	0150-0093	C: FXD CER 0.01μF +80 -20% 100VDCW
A2C33	0150-0073	C: FXD CER 100pF 10% 500VDCW
A2C34	0150-0071	C: FXD CER 400pF 5% 500VDCW
A2C35	0180-0094	C: FXD AL ELECT 100μF 25VDCW
A2C36	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2C37	0150-0093	C: FXD CER 0.01μF -20% +80% 100VDCW
A2C38		NOT ASSIGNED
A2C39	0150-0064	C: FXD CER 15pF 5% 500VDCW
A2C40 and A2C41	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2C42	0140-0201	C: FXD MICA 12pF 5% 500V
A2C43	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2C44	0180-0094	C: FXD AL ELECT 100μF 25VDCW
A2C45	0140-0145	C: FXD MICA 22pF 5% 500VDCW
A2C46	0150-0093	C: FXD CER 0.01μF -20% +80% 100VDCW
A2C47	0150-0093	C: FXD CER 0.01μF -20% +80% 100VDCW
A2C48 and A2C49	0150-0079	C: FXD CER 3.3nF ±10% NPO 500VDCW

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	-hp-Stock No.	Description #
A2C50	0150-0093	C: FXD CER 0.01μF +80% -20% 100VDCW
A2C51	0180-0091	C: FXD AL ELECT 10μF 100VDCW
A2C52	0150-0093	C: FXD CER 10nF +80% -20% 100VDCW
A2C53 and A2C54	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2C55	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2C56	0140-0170	C: FXD MICA 5.6nF 5% 300VDCW
A2CR1 thru A2CR4	1901-0026	DIODE: SILICON 0.5 AMP 200 PIV
A2CR5 thru A2RC8	1901-0029	DIODE: SILICON 0.75 AMP 600 PIV
A2CR9	1902-0048	DIODE: BREAKDOWN 400 mW 6.81 V ±5%
A2CR10	1902-3356	DIODE: BREAKDOWN SIL 56.2 V 10%
A2CR11 and A2CR12	1902-3256	DIODE: BREAKDOWN 400mW 23.7 V ±5%
A2CR13	1902-0048	DIODE: BREAKDOWN 400mW 6.81 V ±5%
A2CR14 and A2CR15		NOT ASSIGNED
A2CR16 and A2CR17	1901-0025	DIODE: SILICON 0.1A 100 PIV
A2CR18 and A2CR19	1901-0040	DIODE: SILICON 30mA 30 PIV
A2CR20	1902-0074	DIODE: BREAKDOWN 400mW 7.15 V ±5%
A2CR21	1902-0048	DIODE: BREAKDOWN 400mW 6.81 V ±5%
A2CR22	1902-0188	DIODE: BREAKDOWN 400mW 4.12 V ±5%
A2CR23 thru A2CR26	1910-0016	DIODE: GERMANIUM 100mA 60 PIV
A2CR27	1902-0048	DIODE: GERMANIUM 400mW 6.81 V 5%
A2CR28	1902-0049	DIODE: BREAKDOWN 400mW 6.19 V ±5%
A2CR29	1901-0040	DIODE: SILICON 30mA 30 PIV
A2CR30 thru A2CR34		NOT ASSIGNED
A2CR35 and A2CR36	1901-0040	DIODE: SILICON 30mA 30 PIV
A2CR37	1902-0037	DIODE: BREAKDOWN 400mW 9.09 V ±10%
A2CR38	1901-0050	DIODE: SILICON 200mA 75 PIV
A2L1	9140-0111	COIL: FXD RF 3.3μH
A2L2	9140-0096	COIL: FXD RF 1μH
A2L3 thru A2L8	9170-0016	INDUCTOR: BEAD
A2Q1 thru A2Q4		NOT ASSIGNED
A2Q5 and A2Q6	1853-0029	TRANSISTOR: SILICON JEDEC2N3702
A2Q7	1853-0001	TRANSISTOR: SILICON PNP
A2Q8	1853-0029	TRANSISTOR: SILICON JEDEC2N3702
A2Q9 and A2Q10		NOT ASSIGNED
A2Q11	1854-0071	TRANSISTOR: SILICON JEDEC2N3391
A2Q12	1854-0019	TRANSISTOR: SILICON NPN
A2Q13	1853-0009	TRANSISTOR: SILICON PNP
A2Q14	1854-0019	TRANSISTOR: SILICON NPN
A2Q15	1853-0009	TRANSISTOR: SILICON PNP

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	-hp-Stock No.	Description #
A2Q16	1854-0019	TRANSISTOR: SILICON NPN
A2Q17	1854-0071	TRANSISTOR: SILICON NPN JEDEC2N3391
A2Q18	1853-0029	TRANSISTOR: SILICON PNP JEDEC2N3702
A2Q19	1854-0019	TRANSISTOR: SILICON NPN
A2Q20	1854-0009	TRANSISTOR: SILICON NPN 2N709
A2Q21	1854-0009	TRANSISTOR: SILICON NPN 2N709
A2Q22	1854-0005	TRANSISTOR: SILICON NPN 2N708
A2Q23 thru A2Q26	1854-0019	TRANSISTOR: SILICON NPN
A2Q27	1854-0005	TRANSISTOR: SILICON NPN 2N708
A2Q28	1853-0009	TRANSISTOR: SILICON PNP
A2Q29 thru A2Q34		NOT ASSIGNED
A2Q35	1854-0071	TRANSISTOR: SILICON NPN JEDEC2N3391
A2Q36	1853-0001	TRANSISTOR: SILICON PNP
A2Q37	1853-0009	TRANSISTOR: SILICON PNP
A2Q38	1854-0019	TRANSISTOR: SILICON NPN
A2Q39 and A2Q40	1854-0267	TRANSISTOR: SILICON NPN
A2Q41 and A2Q42	1854-0091	TRANSISTOR: SILICON NPN
A2Q43	1853-0009	TRANSISTOR: SILICON PNP
A2Q44	1853-0012	TRANSISTOR: SILICON PNP
A2Q45	1854-0019	TRANSISTOR: SILICON NPN
A2R1 thru A2R10		NOT ASSIGNED
A2R11	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2R12 and A2R13	0813-0050	R: FXD WW 100Ω 5% 3 W
A2R14	0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W
A2R15	0758-0004	R: FXD MET OX 2700Ω 5% 1/2 W
A2R16	0758-0034	R: FXD MET OX 2400Ω 5% 1/2 W
A2R17	0758-0003	R:FXD MET OX 1000Ω 5% 1/2 W
A2R18	2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W
A2R19	0758-0042	R: FXD MET OX 1300Ω 5% 1/2 W
A2R20	0761-0005	R: FXD MET OX 2200Ω 5% 1W
A2R21	0812-0012	R: FXD WW 18Ω 5% 3 W
A2R22	0758-0048	R: FXD MET OX 8.2KΩ 5% 1/2 W
A2R23	0758-0028	R: FXD MET OX 270Ω 5% 1/2 W
A2R24	0758-0006	R: FXD MET OX 10KΩ 5% 1/2 W
A2R25	0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W
A2R26	2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W
A2R27	0758-0034	R: FXD MET OX 2400Ω 5% 1/2 W
A2R28	0758-0008	R: FXD MET OX 390Ω 5% 1/2 W
A2R29 thru A2R31		NOT ASSIGNED
A2R32	2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W
A2R33	0758-0067	R: FXD MET OX 750Ω 5% 1/2 W
A2R34	0758-0018	R: FXD MET OX 15KΩ 5% 1/2 W
A2R35	2100-1908	R: VAR COMP LIN 5KΩ 30% 1/8 W
A2R36 and A2R37	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2R38	0758-0016	R: FXD MET OX 300Ω 5% 1/2 W

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	-hp-Stock No.	Description #
A2R39	2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W
A2R40	0758-0082	R: FXD MET OX 130Ω 5% 1/2 W
A2R41 and A2R42	0758-0028	R: FXD MET OX 270Ω 5% 1/2 W
A2R43	0758-0035	R: FXD MET OX 3000Ω 5% 1/2 W
A2R44	0758-0093	R: FXD MET OX 56Ω 5% 1/2 W
A2R45	0683-0685	R: FXD COMP 6.8Ω 5% 1/4 W
A2R46 thru A2R48	2100-1908	R: VAR COMP LIN 5KΩ 30% 1/8 W
A2R49	0758-0071	R: FXD MET OX 4.3KΩ 5% 1/2 W
A2R50	0761-0057	R: FXD MET OX 560Ω 5% 1 W
A2R51	0758-0057	R: FXD MET OX 5600Ω 5% 1/2 W
A2R52	0758-0044	R: FXD MET OX 2200Ω 5% 1/2 W
A2R53	0758-0129	R: FXD MET OX 200KΩ 5% 1/2 W
A2R54	2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W
A2R55	0758-0008	R: FXD MET OX 390Ω 5% 1/2 W
A2R56	0758-0010	R: FXD MET OX 3300Ω 5% 1/2 W
A2R57	0758-0127	R: FXD MET OX 430Ω 5% 1/2 W
A2R58	0758-0002	R: FXD MET OX 560Ω 5% 1/2 W
A2R59	0758-0041	R: FXD MET OX 91Ω 5% 1/2 W
A2R60	0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W
A2R61	0758-0007	R: FXD MET OX 150Ω 5% 1/2 W
A2R62	0758-0032	R: FXD MET OX 820Ω 5% 1/2 W
A2R63	0758-0006	R: FXD MET OX 10KΩ 5% 1/2 W
A2R64	0758-0010	R: FXD MET OX 3300Ω 5% 1/2 W
A2R65	2100-1908	R: VAR COMP LIN 5KΩ 30% 1/8 W
A2R66	0758-0078	R: FXD MET OX 13KΩ 5% 1/2 W
A2R67	0758-0043	R: FXD MET OX 1800Ω 5% 1/2 W
A2R68	0758-0036	R: FXD MET OX 3600Ω 5% 1/2 W
A2R69	0698-5201	R: FXD MET OX 27Ω 5% 1/2 W
A2R70	0758-0002	R: FXD MET OX 560Ω 5% 1/2 W
A2R71	0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W
A2R72	0758-0007	R: FXD MET OX 150Ω 5% 1/2 W
A2R73	0758-0024	R: FXD MET OX 100Ω 5% 1/2 W
A2R74 and A2R75	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2R76 and A2R77	0758-0024	R: FXD MET OX 100Ω 5% 1/2 W
A2R78	0698-5201	R: FXD MET OX 27Ω 5% 1/2 W
A2R79	0758-0126	R: FXD MET OX 51Ω 5% 1/2 W
A2R80	0698-5204	R: FXD MET OX 30Ω 5% 1/2 W
A2R81	0758-0126	R: FXD MET OX 51Ω 5% 1/2 W
A2R82 thru A2R89		NOT ASSIGNED
A2R90	0758-0067	R: FXD MET OX 750Ω 5% 1/2 W
A2R91	0758-0044	R: FXD MET OX 2200Ω 5% 1/2 W
A2R92	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2R93	0758-0096	R: FXD MET OX 110Ω 5% 1/2 W
A2R94	0758-0035	R: FXD MET OX 3000Ω 5% 1/2 W

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	-hp-Stock No.	Description #
A2R95	0758-0008	R: FXD MET OX 390Ω 5% 1/2 W
A2R96	0758-0024	R: FXD MET OX 100Ω 5% 1/2 W
A2R97	0758-0043	R: FXD MET OX 1800Ω 5% 1/2 W
A2R98	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2R99	0758-0044	R: FXD MET OX 2200Ω 5% 1/2 W
A2R100 and A2R101	0761-0041	R: FXD MET OX 56Ω 5% 1 W
A2R102	0758-0026	R: FXD MET OX 82Ω 5% 1/2 W
A2R103	0758-0013	R: FXD MET OX 120Ω 5% 1/2 W
A2R104	0758-0006	R: FXD MET OX 10KΩ 5% 1/2 W
A2R105		NOT ASSIGNED
A2R106 and A2R107	0757-0198	R: FXD MET FLM 100Ω 1% 1/2 W
A2R108	0758-0073	R: FXD MET OX 24KΩ 5% 1/2 W
A2R109	0758-0015	R: FXD MET OX 220Ω 5% 1/2 W
A2R110	2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W
A2R111		NOT ASSIGNED
A2R112	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2R113	0758-0031	R: FXD MET OX 680Ω 5% 1/2 W
A2R114	0758-0126	R: FXD MET OX 51Ω 5% 1/2 W
A2R115		NOT ASSIGNED
A2R116 and A2R117	0698-5203	R: FXD MET OX 39Ω 5% 1/2 W
A2R118	0758-0007	R: FXD MET OX 150Ω 5% 1/2 W
A2R119	0758-0012	R: FXD MET OX 12KΩ 5% 1/2 W
A2RT1	0837-0501	THERMISTOR: 50Ω ±20% 1/2 W
A2RT2	0837-0502	THERMISTOR: 130Ω ±20% 1/2 W
C1	0180-0047	C: FXD ELECT 500μF
C2	0180-0214	C: FXD ELECT 275μF
C3		NOT ASSIGNED
C4	0150-0093	C: FXD CER 0.01μF
DS1		NSR PART OF S 2
F1	2110-0004	FUSE CARTRIDGE SLOW BLOW 1/4 AMP 230 V
	2110-0008	FUSE CARTRIDGE SLOW BLOW 1/2 AMP 125 V
J1	1251-0148	CONNECTOR AC POWER CORD RECEPTACLE
J2 and J3	1251-0083	CONNECTOR BNC
J4	1250-0140	CONNECTOR BNC
J5	1250-0083	CONNECTOR BNC
P1		NSR OF A1 ASSEMBLY
Q1 and Q2	1850-0098	TRANSISTOR PNP GE
Q3 and Q4	1854-0090	TRANSISTOR NPN SI
R1	0758-0049	R: FXD 33KΩMET OX 5% 1/2 W
R2	2100-0053	R: VAR 10KΩ W LIN 20% 2 W
R3	2100-0519	R: VAR 2 X 1KΩ WW 3%
R4	2100-0036	R: VAR COMP 1000Ω 20% 1/2 W
R5	0683-2035	R: FXD 20KΩ COMP 5% 1/4 W
R6	2100-0075	R: FXD 2X 1.2KΩ COMP LIN ±10% 1.25/1.49 W

See introduction to this section

Table 6-1 Reference Desigantion Index (Cont'd)

Reference Designation	-hp-Stock No.	Description #
S1	3101-0100	SWITCH: PUSH BUTTON LIGHTED SPDT 2 AMP AT 125v DC W
S2	3101-0033	SWITCH: SLIDE DPDT NON-SHORTING 0.5 AMP 125 AC-DC
S3		NSR PART OF S5
S4	3101-0011	SWITCH: SLIDE NON-SHORTING 0.5 AMP 125 AC-DC 3 AMP AT 125 VACW ONLY
S5	3100-0507	SWITCH: ROTARY (MULTIPLIER)
S6	3100-0505	SWITCH: ROTARY NSR PART OF A1
T1	9100-0517	TRANSFORMER: POWER
W1	8120-0078	CABLE: AC POWER 7.5 FEET LONG (NEMA PLUG)
W1	8120-0100	CABLE: AC POWER 7.5 FEET LONG (SCHUKO PLUG)
		MISCELLANEOUS
	0370-0077	KNOB: BLK BAR W/ARROW (AMPLITUDE 50Ω)
	0370-0084	KNOB: BLK W/ARROW (AMPLITUDE 600Ω VERNIER 50Ω)
	0370-0099	KNOB: BLK CONCENTRIC (MULTIPLIER)
	0370-0134	KNOB: RED W/ARROW (SYMMETRY)
	1205-0007	NUT HEAT DISSIPATOR
	1205-0008	HEAT DISSIPATOR BODY
	1205-0011	HEAT DISSIPATOR FOR TO-5 AND TO-9
	1400-0084	HOLDER FUSE POST TYPE 3AG
	1490-0032	STAND TILT HALF-MODULE
	5000-0703	COVER SIDE 6X11 SM
	5000-0717	COVER HALF-MODULE BOTTOM
	5040-0700	HINGE
	5060-0728	FOOT ASSY HALF MODULE
	1205-0037	HEAT DISSIPATOR FOR TO-18
	5060-0718	TOP COVER ASSY 7X11SM MODCABCAT
	7100-0389	TRANSFORMER COVER
	11075A	ACCESSORY HANDLE
	00211-04001	ASSEMBLY: DIAL

See introduction to this section

Table 6-2. Replaceable Parts

Part. No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0121-0046	C: VAR CER 9-35pF	28480	0121-0046	1	1
0140-0145	C: FXD MICA 22pF 5% 500VDCW	04062	RDM15C220J5C	1	1
0140-0147	C: FXD MICA 180pF 5% 500VDCW	00853	RDM15F181J5	1	1
0140-0170	C: FXD MICA 5600pF 5% 500VDCW	00853	RDM 20F562J3C	1	1
0140-0180	C: FXD MICA 200pF 2% 300VDCW	04062	RDM19F202G3C	1	1
0140-0194	C: FXD MICA 110pF 5% 300VDCW	04062	RDM15F111J3C	1	1
0140-0201	C: FXD MICA 12pF 5% 500VDCW	00853	RDM15C120J5C	1	1
0150-0064	C: FXD CER 15pF 5% 300VDCW	72982	301001C0G0150J	1	1
0150-0071	C: FXD CER 400pF 5% 500VDCW	56289	19C294A	1	1
0150-0073	C: FXD CER 100pF 10% 500VDCW	71590	40C200A2	1	1
0150-0079	C: FXD CER 3.3nF 10% 500VDCW	71590	CF332	2	1
0150-0093	C: FXD CER 0.01μF -20% +80% 100VDCW	91418	TA	7	1
0150-0096	C: FXD CER 0.05μF ±20% 100VDCW	28480	0150-0096	1	1
0150-0121	C: FXD CER 0.1μF -20% +80% 50VDCW	28480	0150-0121	1	1
0160-0502	C: FXD MYLAR 22nF 1% 60VDCW	28480	0160-0502	1	1
0160-0503	C: FXD MET PAPER 0.22μF 2% 160VDC	28480	0160-0503	1	1
0180-0047	C: FXD ELECT 500μF 75VDCW	28480	0180-0047	1	1
0180-0049	C: FXD AL ELECT 20μF 50VDCW	56289	30D206G050DC6M1	3	1
0180-0091	C: FXD AL ELECT 10μF 100VDCW	56289	30D106G100DD4	1	1
0180-0094	C: FXD AL ELECT 100μF 25VDCW	56289	30D107G025DH4	2	1
0180-0137	C: FXD TA ELECT 100μF 20% 10VDCW	56289	150D107X0010R2	1	1
0180-0214	C: FXD AL ELECT 275μF -10%+50% 200VDCW	28480	0180-0214	1	1
0180-0291	C: FXD TA ELECT 1μF 10% 35VDCW	56289	150D105X9035A2	9	1
0180-0374	C: FXD TA ELECT 10μF 20 VDCW	28480	0180-0374	1	1
0370-0077	KNOB: BLK BAR W/ARROW (AMPLITUDE 50Ω)	28480	0370-0077	1	1
0370-0084	KNOB: BLK W/ARROW (AMP 600Ω, VER 50Ω)	28480	0370-0084	2	1
0370-0099	KNOB: BLK CONCENTRIC (MULTIPLIER)	28480	0370-0099	1	1
0370-0134	KNOB: RED W/ARROW (SYMMETRY)	28480	0370-0134	1	1
0683-0685	R: FXD COMP 6.8Ω 5% 1/4 W	01121	CB68G5	1	1
0683-2035	R: FXD COMP 20KΩ 5% 1/4 W	01121	CB2035	1	1
0698-5201	R: FXD MET OX 27Ω 5% 1/2 W	28480	0698-5201	2	1
0698-5203	R: FXD MET OX 39Ω 5% 1/2 W	28480	0698-5203	2	1
0698-5204	R: FXD MET OX 30Ω 5% 1/2 W	28480	0698-5204	1	1
0757-0069	R: FXD MET FLM 121Ω 1% 1/4 W	28480	0757-0069	1	1
0757-0071	R: FXD MET FLM 247.5Ω 1% 1/4 W	19701	MF6CT-O	1	1
0757-0172	R: FXD MET FLM 37.4Ω 1% 1/2 W	28480	0757-0172	1	1
0757-0198	R: FXD MET FLM 100Ω 1% 1/ W	28480	0757-0198	2	1
0757-0795	R: FXD MET FLM 75Ω 1% 1/2 W	28480	0757-0795	2	1
0757-0801	R: FXD MET FLM 150Ω 1% 1/2 W	28480	0757-0801	2	1
0757-1005	R: FXD MET FLM 61.11Ω 1% 1/2 W	28480	0757-1005	2	1
0758-0002	R: FXD MET OX 560Ω 1/2 W	28480	0758-0002	2	1
0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W	28480	0758-0003	9	1
0758-0004	R: FXD MET OX 2700Ω 5% 1/2 W	28480	0758-0004	1	1
0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W	28480	0758-0005	4	1
0758-0006	R: FXD MET OX 10KΩ 5% 1/2 W	28480	0758-0006	3	1
0758-0007	R: FXD MET OX 150Ω 5% 1/2 W	28480	0758-0007	3	1
0758-0008	R: FXD MET OX 390Ω 5% 1/2 W	28480	0758-0008	3	1
0758-0010	R: FXD MET OX 3300Ω 5% 1/2 W	28480	0758-0010	2	1
0758-0012	R: FXD MET OX 12KΩ 5% 1/2 W	28480	0758-0012	1	1
0758-0013	R: FXD MET OX 120Ω 5% 1/2 W	28480	0758-0013	1	1

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Part. No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0758-0015	R: FXD MET OX 220Ω 5% 1/2 W	28480	0758-0015	1	1
0758-0016	R: FXD MET OX 300Ω 5% 1/2 W	28480	0758-0016	1	1
0758-0018	R: FXD MET OX 15KΩ 5% 1/2 W	28480	0758-0018	1	1
0758-0024	R: FXD MET OX 100Ω 5% 1/2 W	28480	0758-0024	4	1
0758-0026	R: FXD MET OX 82Ω 5% 1/2 W	28480	0758-0026	1	1
0758-0028	R: FXD MET OX 270Ω 5% 1/2 W	28480	0758-0028	3	1
0758-0031	R: FXD MET OX 680Ω 5% 1/2 W	28480	0758-0031	1	1
0758-0032	R: FXD MET OX 820Ω 5% 1/2 W	28480	0758-0032	1	1
0758-0034	R: FXD MET OX 2400Ω 5% 1/2 W	28480	0758-0034	2	1
0758-0035	R: FXD MET OX 3000Ω 5% 1/2 W	28480	0758-0035	2	1
0758-0036	R: FXD MET OX 3600Ω 5% 1/2 W	28480	0758-0036	1	1
0758-0041	R: FXD MET OX 91Ω 5% 1/2 W	28480	0758-0041	1	1
0758-0042	R: FXD MET OX 1300Ω 5% 1/2 W	28480	0758-0042	1	1
0758-0043	R: FXD MET OX 1800Ω 5% 1/2 W	28480	0758-0043	2	1
0758-0044	R: FXD MET OX 2200Ω 5% 1/2 W	28480	0758-0044	3	1
0758-0048	R: FXD MET OX 8200Ω 5% 1/2 W	28480	0758-0048	1	1
0758-0049	R: FXD MET OX 33KΩ 5% 1/2 W	28480	0758-0049	1	1
0758-0057	R: FXD MET OX 5600Ω 5% 1/2 W	28480	0758-0057	1	1
0758-0067	R: FXD MET OX 750Ω 5% 1/2 W	28480	0758-0067	2	1
0758-0071	R: FXD MET OX 4300Ω 5% 1/2 W	28480	0758-0071	1	1
0758-0073	R: FXD MET OX 24KΩ 5% 1/2 W	28480	0758-0073	1	1
0758-0078	R: FXD MET OX 13KΩ 5% 1/2 W	28480	0758-0078	1	1
0758-0082	R: FXD MET OX 130Ω 5% 1/2 W	28480	0758-0082	1	1
0758-0093	R: FXD MET OX 56Ω 5% 1/2 W	28480	0758-0093	1	1
0758-0096	R: FXD MET OX 110Ω 5% 1/2 W	28480	0758-0096	1	1
0758-0126	R: FXD MET OX 51Ω 5% 1/2 W	28480	0758-0126	3	1
0758-0127	R: FXD MET OX 430Ω 5% 1/2 W	28480	0758-0127	1	1
0758-0129	R: FXD MET OX 200KΩ 5% 1/2 W	28480	0758-0129	1	1
0761-0005	R: FXD MET OX 2200Ω 5% 1 W	28480	0761-0005	1	1
0761-0041	R: FXD MET OX 56Ω 5% 1 W	28480	0761-0041	2	1
0761-0057	R: FXD MET OX 560Ω 5% 1 W	28480	0761-0057	1	1
0812-0012	R: FXD WW 18Ω 5% 3 W	28480	0812-0012	1	1
0813-0050	R: FXD WW 100Ω 5% 3 W	28480	0813-0050	2	1
0837-0501	THERMISTOR 50Ω 20%	28480	0837-0501	1	1
0837-0502	THERMISTOR 130Ω 20%	28480	0837-0502	1	1
1205-0007	NUT HEAT DISSIPATOR	28480	1205-0007	2	1
1205-0008	HEAT DISSIPATOR BODY	28480	1205-0008	2	1
1205-0011	HEAT DISSIPATOR FOR TO-5 AND TO-9	98978	TXBF-032-025B	5	1
1205-0037	HEAT DISSIPATOR FOR TO-18	98978	TXBF-019-025B	1	1
1250-0051	CLAMP: NUT BNC	28480	1250-0051	1	1
1250-0083	CONNECTOR BNC	28480	1250-0083	3	1
1250-0140	CONNECTOR BNC	28480	1250-0140	1	1
1251-0148	CONNECTOR POWER 3 PIN MALE	60427	H-1061-2	1	1
1400-0084	HOLDER FUSE POST TYPE 3AG	75915	342014	1	1
1490-0032	STAND TILT HALF-MODULE	28480	1490-0032	1	1
1850-0098	TRANSISTOR GERMANIUM PNP	28480	1850-0098	2	2
1853-0001	TRANSISTOR SILICON PNP	28480	1853-0001	2	2
1853-0009	TRANSISTOR SILICON PNP	28480	1853-0009	5	5
1853-0012	TRANSISTOR SILICON PNP	28480	1853-0012	1	1
1853-0029	TRANSISTOR SILICON PNP JEDEC2N3702	04713	2N3702	4	2

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Part. No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
1854-0005	TRANSISTOR SILICON NPN 2N708	07263	2N708	2	2
1854-0009	TRANSISTOR SILICON 2N709	28480	1854-0009	2	2
1854-0019	TRANSISTOR SILICON NPN	28480	1854-0019	10	10
1854-0071	TRANSISTOR SILICON NPN JEDEC2N3391	01295	SM8748	3	3
1854-0090	TRANSISTOR SILICON NPN	04713	SM858	2	2
1854-0091	TRANSISTOR SILICON NPN	04713	SM9104	2	2
1854-0267	TRANSISTOR SILICONNPN	28480	1854-0267	2	2
1901-0025	DIODE: BREAKDOWN 100mA 100PIV	28480	1901-0025	2	2
1901-0026	DIODE: SILICON 200PIV 0.5 AMP	28480	1901-0026	4	4
1901-0029	DIODE: SILICON 0.75 AMP 600PIV	28480	1901-0029	4	4
1901-0040	DIODE: SILICON 30mA 30PIV	28480	1901-0040	5	5
1901-0050	DIODE: SILICON 200mA 75PIV	28480	1901-0050	1	1
1902-0037	DIODE: BREAKDOWN 400mA 9.09 V ±10%	28480	1902-0037	1	1
1902-0048	DIODE: GERMANIUM 400mA 6.81 V 5%	28480	1902-0048	4	4
1902-0049	DIODE: BREAKDOWN 400mW 6.19 V ±5%	28480	1902-0049	1	1
1902-0074	DIODE: BREAKDOWN 400mW 7.15 V ±5%	28480	1901-0074	1	1
1902-0188	DIODE: BREAKDOWN 400mW 4.12 V ±5%	28480	1902-0188	1	1
1902-3356	DIODE: BREAKDOWN 400mW 56.2 V ±10%	28480	1902-3356	1	1
1902-3256	DIODE: BREAKDOWN 400mW 6.81 V ±	04713	S210939-290	2	2
1910-0016	DIODE GERMANIUM 100mW 60PIV	28480	1910-0016	4	4
2100-0036	R: VAR COM 1000Ω 20% LIN 1/ W	28480	2100-0036	1	1
2100-0053	R: VAR WW 10KΩ 20% LIN 2 W	28480	2100-0053	1	1
2100-0075	R: VAR 2 X 1.2K COMP LIN ±10%	28480	2100-0075	1	1
2100-0519	R: VAR WW 2 X 1KΩ 3%	28480	2100-0519	1	1
2100-1426	R: VAR COMP LIN 250Ω 20% 1/8 W	28480	2100-1426	6	1
2100-1908	R: VAR COMP LIN 5KΩ 30% 1/8 W	28480	2100-1908	5	1
2110-0004	FUSE CARTRIDGE 0.25AMP SLOW BLOW	28480	2100-0004	1	10
2110-0008	FUSE CARTRIDGE 1/2 AMP SLOW BLOW	28480	2100-0008	1	10
3100-0507	SWITCH: ROTARY (MULTIPLIER)	28480	3100-0507	1	1
3101-0011	SWITCH: SLIDE 0.5 AMP 125AC-DC	28480	3101-0011	1	1
3101-0033	SWITCH: SLIDE DPDT 0.5 AMP 125AC-DC	28480	3101-0033	1	1
3101-0100	SWITCH: PUSH BUTTON SPDT 2A 125 VACW	28480	3101-0100	1	1
5000-1157	COVER SIDE 6 X 11 SM	28480	5000-1157	2	1
5000-0717	COVER HALF-MODULE BOTTOM	28480	5000-0717	1	1
5040-0700	HINGE	28480	5040-0700	2	1
5060-0718	TOP COVER ASSY 6 X 11 SM	28480	5060-0718	1	1
5060-0728	FOOT ASSY HALF MODULE	28480	5060-0728	2	1
7100-0389	TRANSFORMER COVER	28480	7100-0389	1	1
8120-0078	CABLE POWER 7.5 FT (NEMA PLUG)	70903	KH4147	1	1
8120-0100	CABLE AC POWER 7.5 FEET LONG (SCHUKO PLUG)				
9100-0517	TRANSFORMER POWER	28480	9100-0517	1	1
9140-0096	COIL FXD RF 1μH	28480	9140-0096	1	1
9140-0111	COIL FXD RF 3.3μH	28480	9140-0111	1	1
9170-0016	BEAD	28480	9170-0016	6	1
00211-04001	ASSEMBLY: DIAL	28480	00211-04001	1	1
00211-63401	ASSEMBLY: ATTENUATOR	28480	00211-63401	1	1

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